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Eskola jazarpenaren ikuspegi biopsikosoziala: hormonen eta testuinguruaren eragina

Biopsychosocial perspective of bullying: influence of hormones and context

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Eskola Jazarpenaren Ikuspegi Biopsikososiala: Hormonen eta Testuinguruaren Eragina.

Biopsychosocial Perspective of Bullying: Influence of Hormones and Context.

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Desberdinak sentitu diren guztiei,
ikusezin bilakatu nahi izan dutenei,
bakardadea lagun dutenei,
eskolako motxilan
jazarpenaren zama daramatenei.
Kaparik gabeko heroi guztiei.

"What you do makes a difference.
And you have to decide what kind of
difference you want to make".

-Jane Goodall-

Esker Ona

"A certain darkness is needed to see the stars" - Osho

Prozesu luze ororen modura, ikerketa-ikasketa garai honek argiak eta itzalak izan ditu. Iluntasuna gertuen izan dudan uneetan, bidea argitu didazuen guztiei, **MILA ESKER.**

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Laburdurak

ADN: Azido desoxirribonukleikoa

ADHN: Arreta Defizitaren eta Hiperaktibitatearen Nahasmendua

AEB: Ameriketako Estatu Batuak

CAR: Cortisol Awakening Response-Kortisol Erantzuna Esnatzean

FSH: Hormona folikuluestimulatzailea

GnRH: Gonadotropinen askapenerako hormona

HPA: Hipotalamo Pituitario Adrenala

HPG: Hipotalamo Pituitario Gonadala

INMA: Infancia y medio ambiente - Haurtzaroa eta ingurumena

JCR: Journal Citation Report

LH: Hormona luteinizatailea

MOE: Munduko Osasun Erakundea

OBVQ: Olweus Bully Victim Questionnaire-Olweusen Erasotzaile Biktima Galdetegia

PECOS: Population, Exposure, Comparator, Outcomes and Study Design–Populazioa, Esposizioa, Konparatzailea, Emaitzak eta Ikerketa diseinua

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses-Berrikuspen sistematikoetarako eta meta-analisietarako lehentasunezko informazio-itemak

RIA: Radioimmunoassay-erradioinmunoanalisia

SEM: Structural Equation Modeling-Egitura-Ekuaziozko Eredua

UNESCO: United Nations Educational, Scientific and Cultural Organization-Hezkuntza Zientzia eta Kulturako Nazio Batuen Erakundea

WoS: Web of Science

Laburpena

Bullying-a haurtzaro eta nerabezaro garaiko osasun publikoko erronka handienetako bat da. Azken hamarkadan faktore biologikoek bullyingarekin duten lotura ikertua izan den arren, oraindik gutxi dira harreman hau aztertzen duten lanak. Doktorego tesi honen helburua eskola jazarpena ikuspegi biopsikosozial batetik lantzea izan da; zehazki, hormona mailak bullyingaren ikerketan integratzea bilatu du, testuinguruko faktoreek duten eragina alde batera utzi gabe. Tesia INMA proiektuko aurrenerabeen datuekin burututako hiru azterlanek osatzen dute. Lehenengo lanak faktore psikosozialek bullying jokabidearekin duten erlazioa identifikatzea bilatu du. Bigarren lanean, hormona mailek eta aldagai psikosozialek bullyingarekin duten eragina aztertu da. Azkenik, hirugarren azterlanean, eskolaren menpeko aldagaien eta bullyingaren estresatzaile rola ikertu da. Tesi honen emaitzek erakutsi dute bullyinga aurrenerabearen portaera arazoekin, familia testuinguruarekin, eskola inguruarekin eta testuinguru sozialarekin lotuta dagoela. Hormona faktoreei dagokionez, kortisola aurrenerabeek bullyingean hartu ditzaketen erasotzaile eta erasotzaile-biktima rolarekin erlazionatzen dela ikusi da. Faktore biologikoak eskola jazarpenaren azterketan txertatzeak, jokabide hau hobeto ulertzen laguntzeaz gain, prebentziorako eta esku-hartzerako norabide berriak planteatzeko erabilgarria izan daiteke.

Abstract

Bullying is considered a major challenge in public health during childhood and adolescence. Even though biological factors have started to be considered in research into bullying in recent decades, relatively few studies have yet attempted to explore the relationship between such factors and bullying. This thesis examines bullying behavior from a biopsychosocial perspective; specifically, it aims to integrate hormone levels into the analysis of bullying without ignoring the effect psychological factors may have. For the purpose of this analysis, various studies were conducted using data of the INMA project. The first study aimed to identify psychosocial factors associated with bullying, the second analyzed the association that hormonal levels and psychosocial factors jointly have with bullying behavior. Finally, the third study examined the role of school in general, and bullying in particular, as a stressor. The results suggest that factors related to preadolescent behavior, and their family, school, and social contexts do influence bullying behavior. Regarding hormonal factors, cortisol was the only hormone associated with the bully and bully/victim role. Integrating biological factors into the study of bullying may not only improve our understanding of this behavior but also suggest new fields of research.

Resumen

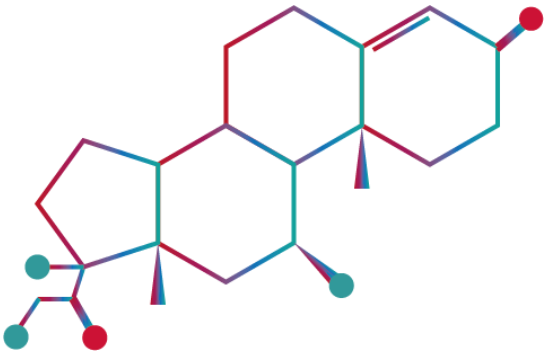
El bullying es considerado uno de los grandes retos de la salud pública durante la infancia y la adolescencia. Aunque durante las últimas décadas los factores biológicos han sido integrados al estudio de este comportamiento, todavía siguen siendo escasas las investigaciones que tratan estudiar la asociación que algunos factores biológicos tienen con la conducta de acoso escolar. Esta tesis doctoral analiza el comportamiento de bullying desde una perspectiva biopsicosocial, concretamente integrando los niveles hormonales al análisis de acoso escolar sin obviar la importancia que tienen los factores psicosociales. La investigación se compone de tres estudios llevados a cabo con los datos de los preadolescentes del proyecto INMA. El primer estudio trata de identificar los factores psicosociales que se asocian a la conducta de bullying. El segundo, analiza la relación que los niveles hormonales y psicosociales presentan con la conducta de bullying. Por último, el tercer trabajo estudia el papel estresor de la escuela en general, y el bullying en particular. Los resultados de esta tesis han encontrado que factores relacionados con la conducta de los preadolescentes, el contexto familiar, el contexto escolar y el contexto social influyen en esta conducta. Respecto a los factores hormonales, los resultados han mostrado que el cortisol se relaciona con el rol de acosador y de acosador-víctima. Integrar los factores biológicos al estudio de la conducta de acoso escolar ayuda no solo a entender mejor este comportamiento, sino también a plantear nuevas direcciones para la prevención y la intervención.

Aurkibidea

Taula/ Irudien Aurkibidea

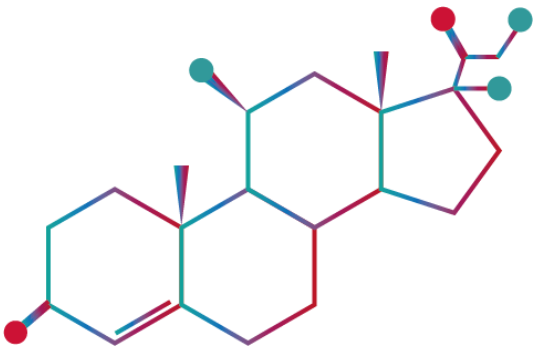
Irudien Aurkibidea

Taulen Aurkibidea



I. ATALA: HASIERAKO ATALA.

Sarrera, Esparru Teorikoa, Metodoa, Emaitzen laburpena eta Eztabaida, Erreferentziak.



1. Introduction

Bullying is one of the most common forms of aggressive behavior during childhood and adolescence and it has been identified as one of the main source of stress during these years (UNESCO, 2019; Vanaelst et al., 2012). Recent evidence suggest that one in three students is involved in bullying worldwide (UNESCO., 2019). Specifically, The World Health Organization (WHO) estimated that between 2 and 32 % of students were victims, while between 1 and 36% of students were bullies (Currie et al., 2012). Bullying can negatively affect children's and adolescents' physical and psychosocial life in both, the short and long term (Moore et al., 2017; Wolke & Lereya, 2015). Not only for its prevalence but also for the consequences it may have, bullying is currently considered a major public health problem (Craig et al., 2009). Given this, it is imperative to continue exploring the factors that affect this behavior.

Though bullying has been studied from a psychosocial perspective for years, it has been shown that human behavior in general, and aggressive behavior in particular, can also be influenced by biological and genetic factors (Garaigordobil & Oñederra, 2010; Popova et al., 2018). In light of the fact that bullying includes aggressive and abusive behaviors, one must ask, in addition to psychosocial variables, which are the underlying biological factors and how they interact. Notably, despite increasing interest in recent decades in the role of hormones in human behavior in the field of neuroendocrinology, to date, little has been

written about hormone levels in bullying. Accordingly, the goal of this thesis is to investigate the influence of psychosocial variables, as well as the impact of neuroendocrine factors, on the different roles that students may adopt in bullying.

This thesis was conducted in the Environmental Epidemiology and Child Neuropsychology (EANPsi) research group at the University of the Basque Country (UPV/EHU) and in the Environmental Epidemiology and Child Development group of Biodonostia Health Research Institute. Data from the INMA (from the Spanish for childhood and the environment, *Infancia y Medio Ambiente*) project has been used for this study. Both the research groups and the research project aim to analyze the impact of the environment on children's physical and neuropsychological development.

The thesis is built around a series of papers, three that have been published as articles in scientific journals listed in the Journal Citation Reports (JCR) database. These three papers analyze bullying from a biopsychosocial perspective, specifically, integrating a neuroendocrinological point of view to complement the psychosocial perspective that has historically been adopted. The thesis is structured as follows: the first section contains the introduction, the theoretical framework, the method used, a summary and discussion of the results and bibliographical references. A second section presents the main conclusions of the thesis and finally, a third section includes the appendices, among which are the published articles.

Furthermore, the thesis is written in Basque (theoretical framework, methodology, hypotheses and objectives, summary and discussion of results) and in English (abstract, introduction, three research papers, and conclusions) in order to obtain the Common European Framework of Reference for Languages C2 level certificate in the Basque language and recognition as an international doctoral thesis respectively.

2. Esparru Teorikoa

2.1. Bullying Kontzeptuaren Eraldaketa

Bullyinga, beste termino batzuekin ere ezaguna dena (eskola jazarpena, berdinen arteko indarkeria, berdinen arteko biktimizazioa), eskola eremuan ematen den indarkeria jokabide bat da. Eskola jazarpenean, intentzionalitatea agertzeaz gain, bi ezaugarri gehiago nabarmentzen dira: errepikakortasuna eta botere-desoreka (Smith et al., 2002).

Bullying fenomenoa aztertzeko interesa Suedian sortu zen 1960 eta 1970 urteen bitartean. Hasierako ikerketek *mobbing* terminoa erabili zuten talde bateko pertsonek beste gizabanako baten aurka modu jarraian egiten zuten indarkeriari erreferentzia egiteko. Hitz honen erabilera, ordea, hainbat ikertzaileren artean eztabaidagai izan zen, eta *mobbing* terminoa ordeztuz, jatorri ingelesa duen *bullying* hitza erabiltzen hasi ziren (Garaigordobil & Oñederra, 2010; Olweus, 2013).

Harrezkeroztik, urteetan zehar bullying kontzeptua eraldatzen joan da. Hasiera batean, jokabide agresiboen azpimultzo gisa definitu zen, zeinak botere-desoreka eta errepikakortasuna zituen ezaugarri nagusitzat (Olweus, 1991). Urte batzuen ostean, zehazki, 1993. urtean, Olweusek, bullyinga, ikasle talde batek biktimatzat hartzen duen beste ikasle bati modu errepikatuan jazarpen fisiko edota psikologikoa egitea zela adierazi zuen (Olweus, 1993).

Nahiz eta 90. hamarkadatik aurrera bullying kontzeptuak eraldaketak jasan dituen, egun, oraindik ere, fenomeno honen

ikerketan aitzindari kontsideratzen den Olweusek proposatutako definizioak erabiliena izaten jarraitzen du (Garaigordobil & Oñederra, 2010): "Ikasle batek eskola jazarpena edo bullyinga jasaten duela diogu beste ikasle batek edo ikasle talde batek hitz mingarriak esatean, iraindu edo iseka egitean, ezizen mingarriak ipintzean, ez ikusiarena egitean, lagun taldetik nahiz euren eginkizunetatik baztertzean, jo, ostiko edo bultza egitean, mehatxatzean, honen inguruan gezurretan, gaizki esaka ibiltzean, zurrumurruak zabaltzean, ohar maltzurrak, mezu faltsuak edo iraingarriak bidaltzean eta beste ikasleek gogoko ez izatea eragiten dutenean. Jazarpen edo abusu ekintza hauek modu errepikatuan ematen dira eta abusua jasaten ari den ikasleari zail egiten zaio bere burua defendatzea. Aldiz, ez dira bullying jokabide edo abusu gisa hartzen, txantxak egitea beste ikasle bati lagun giroan eta jolasean. Ezta, indar edo botere berdintsua duten bi ikasleen arteko eztabaida edo borrokak ere (Olweus, 2007, 2013)".

Fenomeno hau ikertu duten lanek bullying mota desberdinak bereizi daitezkeela ondorioztatu dute: (1) Bullying fisikoa: modu zuzenean pertsonaren gorputzari (jo, bultza, atximurka egin...) edo haren objektu pertsonalei (lapurtu, hautsi, zikindu…) erasotzean datza. (2) Hitzezko bullyinga: pertsona iraintzeko, makurrarazteko edo kikiltzeko asmoz erabilitako hitzezko jarrera negatiboetan datza (irainak, ezizen iraingarriak, mehatxuak…). (3) Bullying soziala: zeharkako jarreren bitartez baztertze jokabideak (bakarrik uztea, jokoetan parte hartzen ez uztea…) martxan ipintzean datza. Jokabide hauen helburua jazarpena jasaten duen pertsonak beste ikaskideekin dituen harremanak kaltetzea da. (4) Bullying

psikologikoa: autoestimua kaltetzen duen jazarpen mota bezala definitzen da eta biktimengan segurtasun eza eta beldurra eragiten ditu. Ekintza hauen artean biktimaz barre egitea, balioa kentzea edo hau umiliatzea aurki daitezke, besteak beste. (5) Cyberbullyinga edo ziberjazarpena: azken hamarkadetan, teknologia berrien erabilerak bultzatuta, bullying mota berriak agertu dira, hauen artean ziberjazarpena nabarmentzen delarik. Eskolako mugak gainditzuz, tresna digitalak erabiltzean gertatu ohi den jokabidea da. Hauen artean, teknologien bitartez mehatxu edota informazio zein irudi pertsonalak zabaltzea aurki daitezke (Garaigordobil & Oñederra, 2010; García-García et al., 2017).

Bullying motak bereizteaz haratago, fenomeno honen baitan ikasleek hartu ditzaketen rolak aztertzea ere interesgarria da. Biktima, jazarpen ekintzak jasaten dituen pertsonari deritzo. Erasotzaile, aldiz, beste ikasle bati fisikoki, psikologikoki, hitzen edo teknologien bitartez erasotzen dion pertsona da. Erasotzaileen artean, azpi-rol desberdinak bereizi daitezke: taldeko burua (bullyinga hasi eta gidatzen duena), laguntzailea (buruari laguntzen diona) eta indartzailea (jazarpen jokabideak burutzea animatzen duena). Ezagunenak diren rol hauetaz gain, erasotzaile-biktima rola ere aurki daiteke. Ikasle hauek, bullying egoeratan erasotzaile nahiz biktima rolak hartu ohi dituzte. Babesle rola ikustea ere ohikoa da, hauek, modu zuzenean edo zeharkakoan biktimari laguntzen dioten ikasleak dira. Bestetik, behatzaile edo ikusleak egongo lirateke, hau da, bullyinga ematen ari dela jakin arren, egoera hau emango ez balitz bezala jokatzen duten pertsonak (Smith, 2016). Azkenik, kanpoko-ikasleak daude, arrazoi

desberdinengatik bullyingean parte hartzen ez duten pertsonak (Jenkins et al., 2016).

2.2. Bullyinga Aztertzeko Ikuspegiak

Bullyinga jokabide konplexua da eta osotasunean ulertu ahal izateko teoria desberdinen ikuspegia lantzea lagungarria suertatu daiteke (Evans & Smokowski, 2016).

2.2.1. Ikuspegi Biologikoa

Ikuspegi honen arabera, jokabidea aldaketa biologikoengatik azaldu daiteke. Ikuspegi hau oinarritzat hartuta, eskola jazarpena alterazio epigenetikoekin, faktore neuroendokrinoekin eta hanturazko markatzaileekin lotura duela ikusi da (Garaigordobil & Oñederra, 2010; Vaillancourt, 2018a).

Ezagutza epigenetikoen arabera, gizabanakoa eragile desberdinen menpe dago, hauen artean, estresa, pobrezia edo konposatu toxikoekiko esposizioa nabarmentzen direlarik. Eragile hauek, prozesu molekular batzuk sortu ditzakete eta azido desoxirribonukleikoaren (ADN) egitura aldatu gabe genomaren jardueran edota giza fenotipoan eraginak sortu ditzakete (Nilsson et al., 2018).

Bullyingari dagokionez, gutxi dira jokabide hau azaltzeko ikuspegi epigenetikoa erabili duten ikerketak. Meta-analisi batek identifikatu zuen, eskola jazarpena jasaten zuten ikasleek ADN metilazioa handitua zutela (Mulder et al., 2020). Ildo beretik, 5-10 urte bitarteko 28 biki pareekin egindako ikerketa batek, bullyinga

jasaten zuten haurrek serotonina garraiatzailea kodetzen duen genearen (5-HTT) metilazioa igota zutela aurkitu zuen (Ouellet-Morin et al., 2013). Era berean, 13 eta 14 urte bitarteko 1149 nerabeekin egin zen beste ikerketa batean ikusi zen bullyinga jasaten zuten ikasleek glukokortikoideen gene errezeptorearen (NR3C1) metilazioa igota zutela (Efstathopoulos et al., 2018). Bestalde, 1658 biki pareekin egin zen ikerketa batean, bullyinga jasan izana epe luzera haur hauek zuten metilazioarekin erlaziorik ez zegoela ikusi zen (Marzi et al., 2018).

Beste ikerketa batzuk, ordea, serotoninaren garraiatzailea kodetzen duen genean polimorfismo bat izatea, osasun mentaleko arazoekin lotuta zegoela aurkitu zuten, batez ere trauma jasaten zuten pertsonetan. Serotoninaren garraiatzailearen genearen eskualde sustatzailean bi aldaki nagusi daude: laburra eta luzea. Aldaki laburra izaten da (bai homozigosian, bai –nahiz eta eragin gutxiagorekin- heterozigosian) nahasmendu eta jokaera arazoekin lotuta egoten dena. Aurreko ikerketetan, eskola jazarpena jasaten zuten haurretan, 5-HTTLPR polimorfismoan alelo motzen bi kopia zituztenek, arazo emozionalak garatzeko arrisku handiagoa zutela ikusi zen (Bejerot et al., 2013; Sugden et al., 2010). Azkenik, beste ikerketa batzuk ondorioztatu zuten 5-HTTLPR polimorfismoak osasun arazoak eta berdinen arteko biktimizazioaren harremana moderatzen zuela (Banny et al., 2013).

Aldaketa neuroendokirnoei erreparatuz, hauek ere eskola jazarpenean eragiten dutela aurkitu dute zenbait lanek. Nahiz eta hau aurrerago atal batean sakonago azalduko den, testosterona

mailak bullyingarekin erlazionatzen zituen ikerketa batek ondorioztatu zuen harreman hau sexuaren menpekoa zela. Nesketan, testosterona maila baxuak hitzezko biktimizazioarekin lotuz eta, mutilen kasuan, ordea, testosterona maila altuak izanik biktimizazioarekin erlazionatzen zirenak (Vaillancourt et al., 2009). Bestetik, bullyingak estres erantzunarekin duen lotura ere aztertua izan da. Kliewer et al.-ek (2019) euren berrikuspen sistematikoan berdinen arteko biktimizazioa kortisol mailekin erlazionatzen zela erakutsi zuten. Berrikuspen lan honek ondorioztatu zuen, biktimak ziren haur eta nerabeetan kortisolaren erreaktibitatea eta goizeko erantzuna baxuagoa zela, eta, ikasle hauetan, kortisolaren eguneko malda lauagoa zela.

Azkenik, eskola jazarpena hanturazko markatzaileen igoerarekin ere erlazionatu da. Zehazki, eskola jazarpenaren biktima izateak, Interleukina-6 eta proteina C-erreaktiboarekin lotura erakutsi du (Vaillancourt, 2018b). Haurtzaroan zehar bullyinga jasan zuten pertsonek, helduaroan C-erreaktibo proteina maila altuagoak zituztela frogatu zen. Bullying erasotzailea izatea, ordea, C-erreaktibo maila baxuagoekin erlazionatu zen (Copeland et al., 2014; Takizawa et al., 2014).

2.2.2. Ikaskuntza Sozialaren Ikuspegia

Ikuspegi honen oinarria, jokabidea baldintzapen klasikoaren, baldintzapen operantearen edo ikaskuntza sozialaren bitartez ikasi daitekeela da. Ikaskuntza teorien artean, Banduraren (1986) teoria sozial kognitiboa nabarmena da, zeinak jokabidea irakaspenengatik eta behaketagatik garatzen dela defendatzen

duen (Swearer et al., 2014). Bullying fenomenoa ikuspegi honetatik aztertuta, Bowesek (2009), etxeko indarkeriaren eraginpean zeuden gazteek erasotzaile rola izateko arrisku handiagoa zutela aurkitu zuen. Horrela, pentsa daiteke, gazte hauek etxean indarkeria modu errepikakorrean ikusiz eta ikasiz, bullying jokabidea garatu zutela.

2.2.3. Atxikimenduaren Ikuspegia

Atxikimenduaren teoria Bowlbyk (1969) garatu zuen haur baten eta haren zaintzaile nagusiaren arteko lotura afektiboari erreferentzia egiteko. Teoria honek harreman sozio-emozionalek gizabanakoaren egitura kognitibo-afektiboetan duten eragina ulertzeko testuinguru bat eskaintzen du. Atxikimenduaren ikuspegiaren arabera, gurasoen eta seme-alaben arteko harreman osasuntsuak haur eta nerabeei oinarri seguruak eskaintzen dizkie beren ingurua ulertzeko.

Ikuspegi hau kontutan hartuta, ebidentzia zientifikoak frogatu du seme-alabek gurasoekin duen atxikimenduak eragina duela pertsonen arteko jokabidearen alor askotan, besteak beste, eskola jazarpenean. Gurasoekiko edo zaintzaileekiko atxikimendu-kalitate eskasa izatea haurrak bullyingean biktima (Eliot & Cornell, 2009; Monks et al., 2005) zein erasotzaile (Monks et al., 2005) rola izateko arrisku-faktore bat dela ikusi da.

2.2.4. Gaitasun Sozialen Ikuspegia

Gaitasun sozialen teoriaren arabera, jokabide arazoak trebetasun sozial ezaren ondorio izan daitezke. Portaera arazoak

dituzten pertsonek seinale sozialak interpretatzeko eta erantzun sozial zuzenak emateko gaitasun eza dutela defendatzen du, hain zuzen, ikuspegi honek (Garaigordobil & Oñederra, 2010). Eskola jazarpena ikuspegi hau kontutan hartuta ikertuz, bullying egoeratan parte hartzen duten ikasleek trebetasun sozial okerragoak izan ohi dituztela ikusi da. Aldiz, bullyingean babesle rola zuten ikasleek gaitasun sozial hobeak erakutsi ohi dituzte (Fox & Boulton, 2005; Jenkins et al., 2016).

2.2.5. Dominantzia Sozialaren Ikuspegia

Dominantzia sozialaren teoriak gizarte guztietan hierarkia sozialak daudela baieztatzen du. Eskola jazarpena ikuspegi honetatik azaltzea posible litzake, berdinen taldean erasotzaileek boterea eta dominantzia izateko helburuz beldurrarazte eta umiliazio ekintzak martxan ipintzen baitituzte. Ildo beretik, eskola jazarpenaren kasuen gehiengoa derrigorrezko bigarren hezkuntzan ematen da, eta honen arrazoietako bat izan daiteke, gazteak eskola inguru berri batera mugitzean hierarkia berriak sortu ohi dituztela eta hauek ezartzeko bullying jokabideak aurrera eramaten dituztela (Evans & Smokowski, 2016; Kumari & Subedi, 2020).

2.2.6. Ikuspegi Eboluzionista

Eboluzioaren teoriaren arabera, gizabanakoak jokabide desberdinak erabiltzen ditu ugalketa eta biziraupena mantentzeko helburuz (Koh & Wong, 2015). Ikuspegi hau oinarri izanik, bullyinga hain zabaldua egonda, egokitzapen abantailarik ekartzen

duen galdetu daiteke. Eskola jazarpena espeziearen egokitzapen tipikoa baino gehiago jotzen da aukerako edo baldintzapeko egokitzapentzat (Volk et al., 2012). Lan batzuk, eskola jazarpena, estatus maila altuago bat, babes fisikoa eta bikote sexual hobeak lortzeko martxan jartzen den estrategia egokitzaile bat izan daitekeela uste dute (Volk et al., 2012; Dane et al., 2017).

2.2.7. Bronfenbrennerren Eredu Sozio-Ekologikoa (1979)

Jokabidean eragina izan ditzaketen aldagaiak maila ekologiko desberdinetan sailkatzen dituen eredu integratzaile bat da Bronfenbrenerrena. Autore honen arabera, gizabanakoa bere munduaren erdigunea da eta ingurune desberdinekin elkarreraginean aritzen da. Teoria honen arabera, beraz, jokabidea gizabanakoaren ezaugarrien eta honen inguruan maila desberdinetan eragiten duten aldagaien menpekoa da (Bronfenbrenner, 1979). Eredu honek bost maila desberdintzen ditu: *gizabanakoa, mikrosistema, mesosistema, exosistema eta makrosistema*. Bullying fenomenoari dagokionez, eredu honek jokabide honetan maila desberdinetan eragiten duten aldagaiak identifikatzen ditu eta azalpen integratzaile bat eskaintzen du kultura desberdinetan jazarpenaren fenomenoa azaldu ahal izateko (Lee, 2011).

Eredu honen lehen maila *mikrosistema* da, gizabanakoa garatzen den mailarik hurbilena da. Sistema hau gizabanakoarekin interakzio zuzena eta denboran mantendua dituzten ingurune guztiek osatzen dute. Bullying fenomenoari erreparatuz, *mikrosistema* honen parte kontsideratzen dira familia, eskola,

berdinen taldea edo komunitatea. Eredu honen bigarren mailari *mesosistema* deritzo eta pertsonak modu aktiboan parte hartzen duen bi ingurune edo gehiagoren arteko harremanari egiten dio erreferentzia. Eskola jazarpenaren kasuan, familiaren eta eskolaren arteko edota familia eta komunitatearen arteko harremanak aurki daitezke, besteak beste. Ereduaren hirugarren maila *exosistema* litzateke, nahiz eta gizabanakoak inguru honekin kontaktu zuzena izaten ez duen, modu ez zuzen batean bere jokabidean eragin dezake. Honen adibide, gurasoen lanaren izaera edota familiaren maila sozioekonomikoa lirateke. Jarraian aurkitzen den mailari *makrosistema* deritzo, hau, egitura sozialek eta maila desberdinetan eragiten duten jarduerek osatzen dute (inguru sozial, kultural, politiko eta antolakuntzakoek). Azkenik, *kronosistema* aurkituko litzateke, zeinak gizabanakoaren eta bere inguruaren aldaketei egiten dion erreferentzia. Talde honetan, familia ereduen egitura aldaketak edota gizabanakoaren bizitzan garrantzia izan duten gertaerak kokatu daitezke (Espelage, 2014).

2.3. Bullying Prebalentzia

Bullyinga munduko eskola gehienetan ematen da, nahiz eta fenomeno honen prebalentziak aldakortasun handiak erakutsi dituen. Aldakortasun hau arrazoi desberdinengatik azaldu daiteke, esaterako, bullyingaren testuinguru soziokulturalaren edota eskola jazarpena ebaluatzeko erabili diren tresnen araberakoa izan daiteke (Menesini & Salmivalli, 2017; Solberg & Olweus, 2003).

Erabilitako tresnei dagokionez, auto-betetze galdetegiak, guraso edo irakasleek betetzeko galdetegiak eta berdinen edo

irakasleen izendatze metodoak aurkitzen dira. Erabilienak auto-betetze galdetegiak izanik ere, hauen artean desberdintasunak aurkitu daitezke. Esaterako, galdera kopuruari, erantzun motari (irekiak, Likert eskala) edota bullyinga bizitako denbora-tarteari (azken urtean, azken 6 hilabeteak, azken 2-3 hilabeteak edota azken 30 egunak) dagokionez (Solberg & Olweus, 2003).

Bullying prebalentzia testuinguru soziokulturalaren arabera ere aldakorra da. Munduko Osasun Erakundeak (MOE) 2009 eta 2010 urteen bitartean, Europa, Estatu Batuak eta Kanadako 10-15 urte bitarteko haur eta nerabeen artean eskola jazarpena ikertu zuen. Ikerketa honen emaitzek biktimizazio balioak herrialdearen eta adin tartearen arabera %2 eta %32 bitartean mugitzen zirela erakutsi zuten, erasotzaileen prebalentzia, ordea, %1 eta %36 bitartean aurkitzen zela ikusi zen (Currie et al., 2012). Mundu mailan egindako beste ikerketa batean ikusi zen 2005 eta 2006 bitartean, 40 herrialdetako 11 eta 15 urteko haurren %26ak bullyingean parte hartzen zutela. Zehazki, ikasleen %12,6 biktimak ziren, %10,7 erasotzaileak eta %3,6 erasotzaile-biktimak (Craig et al., 2009). Hezkuntza Zientzia eta Kulturako Nazio Batuen Erakundeak-United Nations Educational, Scientific and Cultural Organization (UNESCO) berriki egindako ikerketa batean mundu mailan ia hiru haurretatik bat (%32) bullying biktima zela (%7,3) ondorioztatu zuen (UNESCO, 2019).

Europako datuei erreparatuz, Ortega et al.-ek (2012) 8 eta 12 urte bitarte zituzten Italia, Espainia eta Ingalaterrako 5862 ikasleek eskola jazarpenean zuten parte hartzea ikertu zuten. Ikerketa

honen emaitzek, Italia eta Ingalaterrako haurrekin alderatuz, Espainiako haurrek bullying gutxiago jasaten zutela erakutsi zuten. Espainiako datuetan zentratuz, 32 lanekin egindako berrikuspen sistematiko batek, batez beste 14,60 urte (desbiderapen tipikoa= 0,70) zituzten nerabeen %11,45ak eskola jazarpenean parte hartzen zutela ondorioztatu zuen (García-García et al., 2017). Espainia barruan komunitate desberdineko datuei dagokionez, Euskal Herrian 1993 partaideekin eginiko ikerketa batek, ikasleen %13,2 biktimak, %1,6 erasotzaileak eta %2 erasotzaile-biktimak zirela erakutsi zuen (Machimbarrena & Garaigordobil, 2018). Bestalde, Bartzelonako 2727 partaideekin eginiko lan batek haurren %10,7ak bullyinga jasaten duela ondorioztatu zuen (Garcia et al., 2010).

2.4. Bullyingaren Arrisku eta Babes Faktoreak

Urteetan zehar giza jokabidearen jatorria zaintza eta inguruko faktoreen, ala faktore biologiko eta genetikoen menpekoa ote den argudiatu da. Egun, ordea, gainditua dago maiz eztabaidatua izan den ingelesezko "*nature versus nurture*" esaeraren atzean dagoen ikuspegia. Jokabide gehienek bezala, bullyinga jatorri askotariko fenomenoa da eta honen baitan faktore biologiko, sozial nahiz kulturalek elkarlanean eragiten dute (Vaillancourt, 2018a).

Jarraian, bullying jokabidean eragiten duten arrisku eta babes faktoreak aztertzen dira. Nahiz eta elkarreraginean egon, modu errazagoan aurkeztu ahal izateko lau talde nagusietan banatu dira hauek: (1) Gizabanakoaren menpekoak diren faktoreak eta, (2)

familiarekin, (3) eskolarekin eta (4) komunitatearekin erlazionatuta dauden aldagaiak.

2.4.1. Gizabanakoaren Menpekoak Diren Aldagaiak

Eskola jazarpenean eragin dezaketen eta gizabanakoaren menpekoak diren faktoreen artean, ezaugarri biologikoak, ezaugarri fisikoak eta ezaugarri psikologikoak bereizi daitezke.

2.4.1.1. Ezaugarri Biologikoak. Ezaugarri biologikoen artean gehien ikertu den aldagaia sexua izan da. Zenbait berrikuspen sistematikok mutilek biktima, erasotzaile zein erasotzaile-biktima izateko arrisku gehiago dutela ondorioztatu du (Álvarez-García et al., 2015; Jansen et al., 2011; Rodrigues Mandira & Stoltz, 2021). Aldiz, babesle rola nesketan maiztasun handiagoz ematen dela ikusi da (Smith, 2016). Beste lan batzuk, sexua eta bullyingaren arteko harremana bullying motaren menpekoa izan daitekeela aurkitu dute. Rodrigues Mandira eta Stoltzek (2021) euren berrikuspen sistematikoan egiaztatu zuten nahiz eta orokorrean mutilek biktima izateko arrisku handiagoa izan, neskek bullying soziala jasateko arrisku handiagoa zutela. Beste bi lanek, mutilek bullying fisikoa jasateko arrisku handiagoa zutela eta, neskek, aldiz, bullying psikologikoa maiztasun handiagoz jasaten zutela ondorioztatu zuten (Boel-Studt & Renner, 2013; Smith, 2016).

Gizabanakoaren menpekoak diren aldagaien artean, adinak ere garrantzi handia du. Eskola jazarpenaren hasiera, haurrek 7-8 urte dituztela ematen da, gehienezko maiztasuna nerabeek 11-14 urte

bitarte dituztela aurkitzen delarik (Eslea & Rees, 2001; González-Cabrera et al., 2019; González-Cabrera et al., 2021). 14 urtetatik aurrera, aldiz, bullying fenomenoaren maiztasuna gutxituz doala eta egonkor mantentzen dela ikusi da (Álvarez-García et al., 2015; Díaz-Aguado et al., 2013; Hymel & Swearer, 2015).

Ezaugarri neurobiologikoek ere bullying fenomenoarekin lotura izan dezaketela ikusi da. Neurobiologia, nerbio-sistemaren anatomia, fisiologia eta biokimika aztertzen duen biologiaren adarrari deritzo. Hauek horrela, zenbait genek, neurotransmisorek eta aldagai neuroendokrinok bullying jokabidean eragiten dutela ondorioztatu da (Vaillancourt, 2018a). Aurreragoko atal batean hau sakonago landuko den arren, azpimarratzekoa da lan desberdinek eskola jazarpenak, sistema neuroendokrinoarekin (Kliewer, 2006, 2016; Ouellet-Morin et al., 2013; Ouellet-Morin et al., 2011b; Vaillancourt et al., 2008), hantura prozesuaren handitzearekin (Copeland et al., 2014), edota epigenetikako nahasmenduekin, hots, ADN metilazioarekin (Ouellet-Morin et al., 2013) erlazioa erakutsi duela aipatzea.

2.4.1.2. Ezaugarri Fisikoak. Ezaugarri fisiko jakin batzuk izatea, bullyinga egitea edo jasatearen probabilitatearekin erlazionatua dago. D'Urso eta Symondsek (2021) euren berrikuspen sistematikoan aurkitu zuten gizartean onartuak dauden edertasun-kanonetatik kanpo ezaugarriren bat izatea, gainpisua edo obesitatea izatea, edota fisikoki ezgaitua izatea, eskola jazarpenean biktima izateko arrisku faktore direla. Halaber, Álvarez-García et al.-ek (2015) erasotzaileek osasun ahul edo txarra

adierazten zutela ondorioztatu zuten. Azkenik, gaitasun motor ahulagoa izateak biktima izateko arriskua handitzen zuela (Bejerot et al., 2013; Jansen et al., 2011), eta, aldiz, gaitasun motor altuagoak izatea erasotzaile izatearekin erlazionatzen zela (Jansen et al., 2011) aurkitu zuten aurreko ikerketek.

2.4.1.3. Ezaugarri Psikologikoak. Biktimen kasuan, portaera arazoak izatea (Kljakovic & Hunt, 2016), jokaera barnerakoiak izatea (Kljakovic & Hunt, 2016), arazo emozionalak izatea (D'Urso & Symonds, 2021), komunikatzeko hizkuntza zailtasunak edota zailtasun sozialak izatea arrisku faktore gisa identifikatu ziren (Jenkins, et al., 2017b). Aldiz, inteligentzia altua, konpetentzia sozial egokia, arazoak konpontzeko gaitasuna izatea, autoestimu eta autokontzeptu egokia izatea, bizitzarekin gogobetetze maila egokiak izatea edota jarrera prosoziala izatea babes faktoretzat hartu dira (Jackson et al., 2017; Zych et al., 2019).

Erasotzaileen kasuan, nortasun arazoak (D'Urso & Symonds, 2021), jokabide kanporakoiak (Álvarez-García et al., 2015; D'Urso & Symonds, 2021; Kljakovic & Hunt, 2016), jokabide agresiboak izatea (Jenkins, et al., 2017a); arazo emozionalak izatea (Álvarez-García et al., 2015), gaitasun prosozial gutxiago izatea edota lider gaitasun gehiago izatea (Jenkins, et al., 2017) arrisku faktore gisa identifikatu dira.

Erasotzaile-biktima rolari dagokionez, enpatia maila altua eta arazoak konpontzeko gaitasun altuak izatea erasotzaile-biktima izateko arriskua gutxitzen duela ondorioztatu zuen berrikuspen sistematiko batek (Zych et al., 2019). Aldiz, rol hau hartzen duten

pertsonak gutxiago sozializatzen zutela aurkitu zuen beste lan batek (Jenkins et al., 2017a). Azkenik, defendatzaileei dagokionez, gaitasun prosozial eta enpatia maila altuak dituztela ikusi da (Jenkins et al., 2017a).

Garapen neuropsikologikoan nahasmendu bat izatea haur eta nerabeek bullyingean duten inplikazioan eragin dezake. Funtzio exekutiboak trebetasun kognitiboak dira eta jokabidean eragiten dute, autoerregulazioa, aktibitate kognitiboa eta emozionalaren bitartez. Funtzio exekutibo ahulek biktima (Kloosterman et al., 2014; Medeiros et al., 2016; Verlinden et al., 2014), erasotzaile (Medeiros et al., 2016; Verlinden et al., 2014) eta erasotzaile-biktima (Verlinden et al., 2014) izateko arriskua areagotzen dutela, eta, aldiz, funtzio exekutibo egokiagoak izatea, erasotzaile zein biktima rola izateko arriskua gutxitzen dutela (Liu et al., 2017) erakutsi du aurreko ebidentziak.

2.4.2. Familia Aldagaiak

Haurrak familia testuinguruan hasten dira lehen aldiz beste pertsona batzuekin harremanak izaten, eta bertan, elkarbizitza eta jokabide arauak bereganatzen dituzte. Hori dela eta, familiarekin lotura duten zenbait aldagaik, haurrek beste pertsonekin eraikitzen dituzten harremanetan eragina izan dezakete (Machimbarrena et al., 2019).

Familiaren ezaugarri soziodemografikoen artean, guraso edo familiaren maila sozioekonomikoa da gehien ikertua izan den aldagaia. Meta-analisi batek erakutsi zuen familiaren maila

sozioekonomiko baxua biktima, erasotzaile zein erasotzaile-biktima izateko arrisku faktore bat zela (Tippett & Wolke, 2014). Aurreko lan batek, ostera, maila sozioekonomiko altua eskola jazarpena jasateko arrisku faktore bat izan zitekeela topatu zuen (Foster & Brooks-Gunn, 2013).

Familiaren egitura ere ikertua izan da bullying jokabidearekin izan dezakeen loturarengatik. Familia ez tradizionala zuten haurrek erasotzaile izateko arrisku gehiago zutela erakutsi zuen berrikuspen sistematiko batek (Álvarez-García et al., 2015). Beste lan batzuk, guraso bakarreko familia batean bizitzeak bullyingean biktima (Benavides Abanto et al., 2021; Bevilacqua et al., 2017; Jablonska & Lindberg, 2007) zein behatzaile moduan (Han et al., 2017) parte hartzeko arriskua areagotzen zuela aurkitu zuten. Aitzitik, bi gurasoekin bizitzea babes faktore gisa identifikatu zen biktima (Cassidy, 2009; Shetgiri et al., 2013; Spriggs et al., 2007) edo erasotzaile (Spriggs et al., 2007) izateko. Halaber, familia testuinguruaren antolakuntzarekin jarraituz, heldu askorekin bizitzea babes faktore bat dela ikusi zen, eta aldiz, gaixotasun kronikoa zuen familiako kide batekin bizitzea biktima izateko arriskua handitzen zuela aurkitu zen (Pervanidou et al., 2019).

Gurasoen osasun mentala eta hauek haurrekin ezartzen dituzten harremanak ere aztergai izan dira bullying fenomenoa ikertzean. Gurasoen osasun mental okerrago batek biktima zein erasotzaile izateko arriskua areagotzen zuela ondorioztatu zuten aurreko bi berrikuspen sistematikok (Álvarez-García et al., 2015; Nocentini et al., 2019). Gainera, gurasoekin atxikimendu sendoago

bat izatea bullyinga jasatearen aurrean babes faktore gisa jokatzen zuela ondorioztatu zuten Rodrigues Mandira eta Stoltzek (2021) beren lanean. Ildo beretik, guraso-estiloei dagokionez, guraso-estilo autoritarioa biktima nahiz erasotzaile izateko arrisku faktore gisa identifikatu zen (Machimbarrena et al., 2019; Nocentini et al., 2019). Modu berean, guraso-estilo zabarra edo permisiboa izatea ere biktima nahiz erasotzaile rola hartzeko arriskua handitzen zuela ikusi zen (Machimbarrena et al., 2019). Guraso-estilo demokratikoa, aldiz, bullying jokabidean inplikatua egoteko babes faktore bat dela kontsideratu da (Machimbarrena et al., 2019).

Bestalde, familian giro egoki bat izatea, modu eraginkorrean komunikatzea, gurasoak haurraren hazkuntzan inplikatuak egotea eta hauei behar dutenetan laguntza, babesa eta estimua eskaintzea biktima, erasotzaile, nahiz erasotzaile-biktima izateko babes faktore gisa jarduten dutela frogatu da (Machimbarrena et al., 2019; Nocentini et al., 2019; Zych et al., 2019). Kontrako ildotik, gurasoen gehiegizko kontrola, guraso eta seme-alaben artean komunikazio arazoak egotea, familia harreman estresagarriak izatea edota familia giroan gatazka zein indarkeria egotea, haur zein nerabeek bullyingean biktima (Machimbarrena et al., 2019; Nocentini et al., 2019), erasotzaile (Álvarez-García et al., 2015; Nocentini et al., 2019) zein erasotzaile-biktima (Bowes et al., 2009) izateko arrisku faktore gisa identifikatu dira.

2.4.3. Eskola Aldagaiak

Eskolan, haur eta nerabeek familia testuingurutik kanpo beste pertsona batzuekin harremanak garatzen eta mantentzen ikasten

dute. Gehienetan harreman horiek asebetegarriak eta gizabanakoaren garapenerako lagungarriak dira. Baina, batzuetan, ikaskideen artean ematen diren dinamikak negatiboak dira eta gatazka egoerak eman daitezke, eskola jazarpenean amaitu ditzaketenak. Horregatik, pentsa daiteke, eskolari lotutako zenbait ezaugarrik bullying garapenean arrisku zein babes faktore gisa jardun dezaketela.

Eskola egiturak bullyingarekin duen lotura gutxitan ikertu da. Azeredo et al.-ek (2015) bere berrikuspenean topatu zuten eskola antolakuntza eta egitura (eskola tamaina, gelako tamaina, eskola kokatuta dagoen hiriko gunea) bullying maiztasunarekin erlazionatzen saiatzen ziren lanek emaitza desberdinak aurkitzen zituztela eta hortaz, ezin zela ondorio argirik atera.

Eskolako klima eta haurrek eskolako beste ikasleekin eta irakasleekin zituzten harremanek, ordea, lotura zuzena erakutsi dute eskola jazarpenarekin. Alde batetik, eskolan klima egoki bat egotea, ikasle guztiak berdintasunez tratatuak zirela hautematea, baliabide berdinak dituztela sentitzea eta eskolan arauak egotea, biktima, erasotzaile, eta erasotzaile-biktima izateko arriskua gutxitzen zuela ondorioztatu da (Álvarez-García et al., 2015; Azeredo et al., 2015; Rodrigues Mandira & Stoltz, 2021; Zych et al., 2019). Bestalde, irakasleekin harreman egoki bat izatea eta irakasleek bullyingaren aurkako jarrerak dituztela sentitzea bullyingean inplikatuak izateko arriskua gutxitzen duela aurkitu da (Álvarez-García et al., 2015; Han et al., 2017; Saarento et al., 2013). Halaber, ikaskideekin harreman on bat izatea bullying biktima

izateko nahiz behatzailea izateko arriskua gutxitzen duela ikusi da (Han et al., 2017; Zych et al., 2019). Aldiz, berdinen taldean estatus maila altua izateak erasotzaile (Álvarez-García et al., 2015) zein erasotzaile-biktima izateko arriskua handitzen du (Zych et al., 2019).

Azkenik, aurretik jazarpena jasan izana biktima (Kljakovic & Hunt, 2016; Rodrigues Mandira & Stoltz, 2021) zein erasotzaile-biktima (Rodrigues Mandira & Stoltz, 2021) izateko arriskua handitzen duela aurkitu zuten bi berrikuspen lanek.

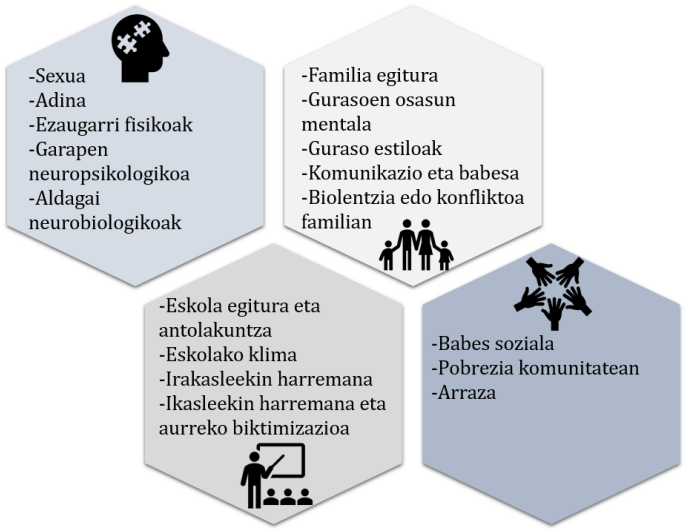
2.4.4. Komunitateko Aldagaiak eta Aldagai Sozialak

Familia eta eskolako testuingurutik at, komunitateko beste zenbait eremuetan ere beste pertsona batzuekin elkarbizitzen ikasi behar dute haur eta nerabeek. Bullyingarekin lotura izan dezaketen arrisku eta babes faktoreen artean, haur eta nerabeen euskarri edota sostengu soziala izan da ikertuena. Horrela, lan desberdinek aurkitutakoaren arabera, euskarri sozial hobea izatea bullyingean biktima (Zych et al., 2019), zein erasotzaile (Álvarez-García et al., 2015; Zych et al., 2019) rola garatzeko babes faktore bat izan daitekeela ikusi da. Bestalde, komunitatean pobrezia izatea bullying gehiago gertatzeko arriskua igotzen dela ondorioztatu da (Azeredo et al., 2015; Foster & Brooks-Gunn, 2013).

Bi berrikuspen lanek gutxiegitasun etniko baten parte diren haur eta nerabeek biktima (D'Urso & Symonds, 2021) nahiz erasotzaile izateko arrisku gehiago zutela (Álvarez-García et al., 2015) ondorioztatu zuten.

1 Irudia

Bullyingarekin erlazionatutako aldagai biopsikosozialen laburpena



2.5. Bullyingak Osasun Fisiko Nahiz Psikosozialean Izan Ditzakeen Ondorioak

Azken urteetan eskola jazarpenaren fenomenoa haurtzaroa eta nerabezaroan zehar ematen den osasun publikoko arazo nagusitzat identifikatu da. Eskola garaian bullying egoeratan parte hartzeak bizitzako momentu eta alor desberdinetan ondorioak izan ditzake.

2.5.1. Bullyingak Osasun Mentalean Dituen Ondorioak

Bullyingak sortu ditzakeen ondorioen artean gehien ikertu den arloa osasun mentalarena izan da (Mcdougall & Vaillancourt, 2015). Olweusek 1993. urtean lehen aldiz frogatu zuen, 11 urterekin eskola jazarpeneko biktimak izan ziren haurrek

helduaroan depresio agerraldiak bizitzen zituztela (Olweus, 1993). Ikerketa hau lagin txiki batekin egin bazen ere, beste ikertzaile askori bidea irekitzeko balio izan zuen. Ordutik, ugari izan dira jazarpena jasateak osasun mentalean izan ditzakeen ondorioak aztertu dituzten lanak.

Bullying biktima izateak osasun mentalean eragiten duela aurkitu da, batik bat, depresioa, antsietatea, estresa, sintoma psikotikoak, portaera arazoak, sustantzia abusua (alkohol, tabako eta drogen) edota auto-lesioa eraginez eta suizidioa gauzatuz (Chouhy et al., 2017; Halliday et al., 2021; Holt et al., 2015; Moore et al., 2017; van Geel & Vedder, 2014).

Luzetarako ikerketekin egindako berrikuspen eta meta-analisiek, haurtzaro edo nerabezaroan zehar biktima izatea helduaroko portaera barnerakoiekin, bereziki depresioa eta antsietatearekin (Klomek et al., 2015; Takizawa et al., 2014; Wolke & Lereya, 2015), portaera kanporakoiekin (agresibitatea, delinkuentzia edota arreta arazoekin) (Reijntjes et al., 2011) edota auto-lesio eta suizidioarekin (Klomek et al., 2015; Reijntjes et al., 2011; Wolke & Lereya, 2015) erlazionatzen zela ondorioztatu dute.

Eskola jazarpenak biktimen osasun mentalean eragiteaz gain, erasotzaileengan ere eragiten duela ikusi da. Olwueusek, 2011. urtean, eskola garaian erasotzaile izatea, helduaroan gizabanakoak izan dezakeen indarkeriarako gaitasunarekin, bai eta kriminalitate neurriekin lotuta zegoela frogatu zuen (Olweus, 2011). Orduz geroztik, biktimen kasuan baino gutxiago ematen den arren, erasotzaile izatea, depresio edo auto-lesioarekin erlazionatzen dela

baieztatu dute berrikuspen lanek (Holt et al., 2015; Wolke et al., 2013). Honetaz gain, alkohola eta tabakoaren erabilera desegokiarekin ere erlazionatuta dagoela ikusi da (Gaete et al., 2017).

Luzerako ikerketek nahasmendu mental hauetariko batzuk denboran zehar mantendu daitezkeela erakutsi dute. Hauen artean depresioa, antsietatea, panikoa, nortasun arazoak, drogen abusua, kriminalitatea eta indarkeria aurki daitezke (Copeland et al., 2013; Klomek et al., 2015; Sigurdson et al., 2015; Wolke & Lereya, 2015).

Biktima eta erasotzaileez ez ezik, erasotzaile-biktima eta behatzaile bezala parte hartzen duten haur eta nerabeek ere epe motz zein luzera arazo mentalak izateko arrisku gehiago dute. Alde batetik, eskola jazarpenean erasotzaile-biktima rola hartzen zuten haurrek depresioa, antsietatea, esperientzia psikotikoak, jokaera kanporakoiak edota suizidioa pairatzeko arrisku gehiago zuten (Klomek et al., 2015; Le Menestrel, 2020). Ildo beretik, substantzia abusua izateko arrisku gehiago izan ohi dute (Gaete et al., 2017). Azkenik, Le Menestrelek (2020), behatzaileek ere osasun arazo mental gehiago pairatu ohi zituztela -antsietatea, edo segurtasun eza barne-, aurkitu zuen.

2.5.2. Bullyingak Osasun Fisikoan Dituen Ondorioak

Bullyingak osasun fisikoan gauzatzen dituen ondorioen artean gehien ikertu direnak sintoma somatikoak izan dira. Azken urteetako berrikuspen eta meta-analisi lanek, biktimak diren ikasleek sintoma somatikoak pairatu ohi dituztela erakutsi dute,

hauen artean, tripetako mina, bizkarreko mina, buruko mina edota lo egiteko zailtasunak nagusitzen direlarik (Chouhy et al., 2017; Moore et al., 2017; Wolke & Lereya, 2015). Lan gehienak biktimetan oinarritu diren arren, Armitagek (2021) bere lanean erakutsi zuen erasotzaile eta erasotzaile-biktimek ere sintoma somatikoak izan ohi dituztela. Sintoma somatikoez haratago, biktimizazioa gainpisua eta obesitatearekin eta orokorrean osasun eskasa izateko pertzepzioarekin edo osasun arazo gehiagorekin erlazionatu da (Holt et al., 2015; Moore et al., 2017).

Bestetik, ikerketa berrienek eskola jazarpenak neurobiologian eragina izan dezakeela erakutsi dute. Neuroirudiko ikerketek min sozialak eta min fisikoak sare neurologiko bera dutela ondorioztatu dute (Vaillancourt et al., 2010). Nahiz eta eskola jazarpenak garunean izan ditzaken ondorioak oraindik ezezagunak izan, eskola jazarpenak gorputzeko estresaren erantzuna gauzatzen duen sisteman, hots, HPA (Hipotalamo - Pituitario - Adrenal) ardatzean, eragiten duela ikusi da (Mcdougall & Vaillancourt, 2015). Halaber, HPA ardatzean nahasmenduren bat egotea, osasun mental, funtzio kognitibo eta osasun fisikoko arazorekin erlazionatu da (Le Menestrel, 2020). Bestalde, eskola jazarpenak hantura kronikoa eragin dezakeela frogatu da. Zehazki, C proteina erreaktiboaren mailen igoeran eragin dezake eta hauek modu kronikoan igota egotea gaixotasun kardiobaskularrekin, arazo metabolikoekin eta osasun mentaleko nahasmenduekin lotu da (Copeland et al., 2013).

2.5.3. Bullyingak Arlo Akademiko eta Sozialean Dituen Ondorioak

Bullyingak haurraren bizitza soziala eta arlo akademikoa hunkitu dezake. Meta-analisi eta berrikuspen berrienek frogatu dute bullyingak haur eta nerabeen eskola arloan eragiten duela. Alde batetik, biktima (Armitage, 2021; Chouhy et al., 2017; Halliday et al., 2021; Moore et al., 2017; Wolke & Lereya, 2015), erasotzaile edota erasotzaile-biktima rola duten haur eta nerabeek eskola egokitzapen okerragoa izan ohi dute (Armitage, 2021; Gini & Pozzoli, 2009; Wolke & Lereya, 2015). Bestetik, eskola jazarpenak, biktima, erasotzaile nahiz erasotzaile-biktimen eskola errendimenduan ere eragin dezakeela ikusi da (Gini & Pozzoli, 2009; Moore et al., 2017). Arlo sozialari dagokionez, biktimak izan diren haurrak epe luzera lagunak izateko edo bikote batekin bizitzeko arazo gehiago izan ohi dituzte (Wolke & Lereya, 2015). Halaber, biktima izatea sexu jokaera arriskutsuekin erlazionatu da (Moore et al., 2017).

1 Taula

Bullyingak izan ditzakeen ondorioen laburpena

Ondorioak	Biktima	Erasotzaile	Erasotzaile-Biktima	Behatzaile
Osasun mentala				
Jokabide barnerakoiak (antsietatea, estresa, sintoma psikotikoak eta panikoa).	X	X	X	X
Jokabide kanporakoiak (agresibitatea, indarkeria eta kriminalitatea).	X	X	X	
Nortasun arazoak		X		
Sustantzia erabilera desegokia (alkohol, tabako eta drogen abusua)	X	X	X	
Auto-lesio eta suizidioa	X	X		
Osasun fisikoa				
Sintoma somatikoak (buruko mina, tripako mina, nekea, lo egiteko zailtasunak…)	X	X	X	
Gainpisua eta obesitatea	X			
Arazo neuroendokrino-inmunitarioak (HPA ardatzean arazoak eta hantura kronikoa)	X			
Eskola ingurua eta testuinguru soziala				
Eskola errendimendua	X	X	X	
Eskola egokitzapena (eskolako parte sentitzea, eskolan onartuak sentitzea)	X	X	X	
Sexu jokabide arriskutsuak	X			
Lagun eta bikoteekin harremanak ezartzeko zailtasunak	X			

2.6. Hipotalamo-Pituitario-Adrenal (HPA) eta Hipotalamo-Pituitario-Gonaldal (HPG) Ardatzek Bullyingean Duten Papera

Tradizionalki giza jokabidea ikuspegi psikosozial batetik aztertua izan da. Hala ere, azken urteetan hainbat faktore biologikok jokabidean eragiten dutela frogatu da, hauen artean, sistema neuroendokrinoaren papera nabarmena izanik (Moya et al., 2016). Hipotalamoa eta hipofisia sistema neuroendokrinoko egiturak dira eta gure gorputzeko ardatz nagusiak kontrolatzeaz arduratzen dira. Ardatz hauen artean Hipotalamo-Pituitario-Adrenal (HPA) eta Hipotalamo-Pituitario-Gonadal (HPG) ardatzak aurkitzen dira, hurrenez hurren, estresaren erantzunaren eta ugalketa prozesuaren arduradunak direnak (Gore, 2013).

2.6.1. HPG eta HPA Ardatzen Anatomia eta Fisiologia

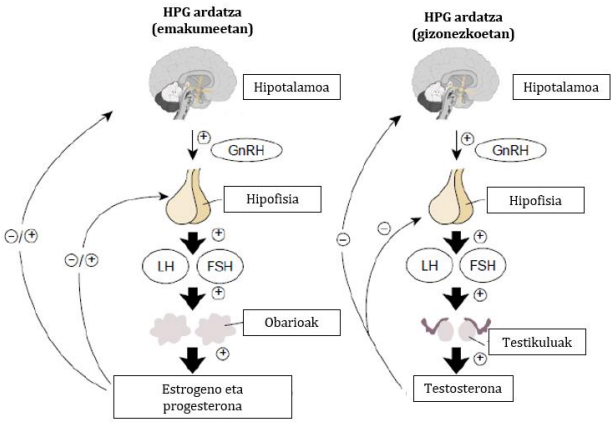
2.6.1.1. HPG Ardatzaren Fisiologia. HPG ardatza, ugalketa mantentzeaz arduratzen da, espezien biziraupenerako oinarrizko funtzioetako bat dena (Gore, 2013). HPG ardatzaren funtzionamendua hipotalamoko zenbait neuronek gonadotropinen askapenerako hormona (GnRH) jariatzean hasten da. Hormona hau hipofisi aurreko lobulura iristean, gonadoestimulinen, hau da hormona folikulu-estimulatzailearen (FSH) eta hormona luteinizatzailearen (LH) sintesia eta askapena gauzatzen du. Bi hormona hauek gonadak (testikuluak eta obarioak) estimulatzeaz arduratzen dira, hauek sexu hormonak (androgeno eta estrogenoak) jariatu ditzaten (Corradi et al., 2016; Dwyer & Quinton, 2019). Sexu hormonen produkzioa ardatz honek duen atzeraelikadura negatiboko mekanismo bati esker kontrolatzen da.

Hormona maila nahikoa dagoenean, GnRH eta gonadotropinek hormona gehiago ez isurtzea eragin dezakete (Corradi et al., 2016) (2. irudia).

Ardatz honen aktibitatea garapeneko fase edo garai desberdinetan zehar aldakorra da. Fetu garai hasieran, amaren hormona mailek kontrolatzen dute ardatz hau. Bizitzako lehen astera arte, gonadotropina eta sexu hormona mailak baxuak izaten dira, eta bizitzako lehen eta hirugarren hilabeteen bitartean hormona maila horiek igotzen doaz. Ardatz hau haurtzaroan zehar isilik mantentzen da eta pubertaro garaian berriro aktibatzen da. Hauek horrela, 10-12 urte bitarte, pubertaroaren hasierarekin batera, androgeno mailen igoera bat ematen da eta une honetatik aurrera ardatz hau garatuz joaten da, ugalketa funtzioak lortu arte (Kuiri-Hänninen et al., 2014).

2 Irudia

HPG ardatza

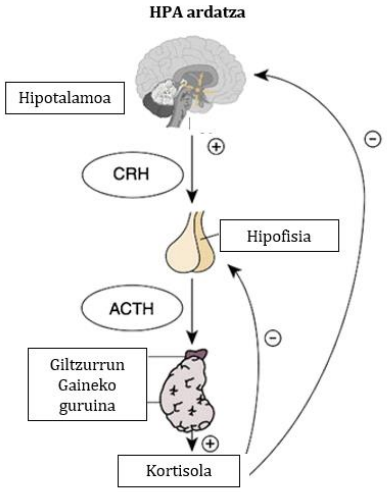


Oharra: HPG ardatzaren fisiologia. The Endocrine System: an overview (p.162), Hiller-Sturmhöfel, S. eta Bartke, A., 1998, *Alcohol Health & Research World*, 22(3)-tik moldatua.

2.6.1.2. HPA Ardatzaren Fisiologia. HPA ardatza, eguneko kortisol erritmoa kontrolatzeaz gain estresarekiko erantzunaz arduratzen den sistema biologiko nagusietako bat da. HPA ardatzaren funtzionamendua hipotalamoan CRH (kortikotropinaren askapenerako hormona) jariatzen denean hasten da. Odol sistematik garraiatuz hormona hau hipofisira iristen da, non, ACTH (kortikotropina) hormonaren jarioa aktibatuko duen. Jarraian, kortikotropina, giltzurrun gaineko guruinetara iristen da, zeinak, glukokortikoide desberdinak askatzen dituen. Ardatz honetan, HPG ardatzean gertatzen den modura hormona mailak atzeraelikadura negatiboko mekanismo baten bitartez kontrolatzen dira. Glukokortikoide nahikoa dagoenean, hauek hipofisi zein hipotalamoaren erantzuna inhibitu dezakete (3. irudia) (Moya et al., 2016).

3 Irudia

HPA ardatza



Oharra: HPA ardatzaren fisiologia. The Endocrine System: an overview (p.162), Hiller-Sturmhöfel, S. eta Bartke, A., 1998, *Alcohol Health & Research World*, 22(3)-tik moldatua.

Fisiologikoki osasuntsu dagoen gorputz batean kortisolak egunean zehar erritmo zehatz bat jarraitzen du. Goizean esnatu eta 30 minutura gutxi gora-behera eguneko kortisol maila altuenak aurkitzen dira. Igoera honen ostean, kortisol mailak progresiboki jaisten dira egunean zehar gaua iritsi arte, maila baxuenak loa hastean aurkitzen direlarik.

Ardatz honen funtzionamendua estresaren erantzunarekin zuzenki lotuta dago. Estresatzaile desberdinen aurrean gure organismoak erantzun fisiologiko bat ipintzen du martxan.

Walter Cannon fisiologoak 1920. hamarkadan homeostasiaren kontzeptua erabili zuen lehen aldiz, gorputzak modu egokian funtzionatzeko organismoko orekari erreferentzia egiteko. Arrisku desberdinen aurrean oreka hau mehatxatuta ikustean, gorputzak erantzun bat aktibatzen duela azaldu zuen, ingelesezko *"fight or fligh"* erantzuna bezala definitu zuena. Arrisku baten aurrean animalia eta gizabanakoen organismoak homeostasia mantentze aldera, aldaketa fisiologiko desberdinak martxan ipintzen dituen erantzun bat aktibatzen zela azaldu zuen (McCarty, 2016).

Baina, 1936. urtean izan zen Hans Seyleren eskutik estresaren erantzuna lehen aldiz aipatu zenean. Gure gorputzeko erantzun hau "egokitze sindrome-orokorra" bezala izendatu zuen eta honen baitan hiru fase desberdindu zitezkeela erakutsi zuen (González & Escobar, 2002):

Alarma fasean estresatzailea identifikatu ostean HPA ardatza aktibatzen da eta gure egoera horri aurre egiteko gorputzak

erreakzio desberdinak ipintzen ditu martxan: organismoko defentsen mugikortasuna, bihotz maiztasunaren handitzea, globulu gorrien askatzea, odolaren garraioa gorputzeko organo garrantzitsuetara (garuna, bihotza), arnas maiztasunaren igoera, pupilen dilatazioa…

Egokitzapen fasean organismoa eraso gisa identifikatu dituen estresatzaile horri erantzun bat ematen saiatzen da eta egoera berrira egokitzen saiatzen da.

Azkenik, **agorpen fasea** ematen da. Fase honetn, estresatzailearen iraupena edota intentsitateagatik gorputzeko defentsak agortzen hasten dira. Gorputza fase honetara iristean arazoak eman daitezke, organismoa ahulduz edota immunitate sisteman eta zirkulazio sisteman kalteak gauzatuz.

Seylek estresaren erantzuna estresatzaile guztien aurrean berdina zela ondorioztatu zuen. Baina, urte batzuren ostean Chrousos eta Goldek (1992) azalpen hauek zabaldu zituzten. Ikertzaile hauek estresaren erantzuna estresatzaile bakoitzaren aurrean espezifikotasuna erakusten zutela baieztatu bazuten ere, espezifikotasun hau estresatzailearen larritasuna handitzean galdu egiten zela ikusi zuten.

2.6.2 Sexu Hormonek eta Kortisolak Bullyingarekin Duten Lotura: Berrikuspen Sistematizatu bat

Berrikuspena burutzeko, berrikuspen sistematikorako eta meta-analisietarako lehentasunezko informazio itemak, hots, PRISMA gida (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) jarraitu zen (Moher et al., 2009). Berrikuspen honen helburu nagusia HPG eta HPA ardatzen menpekoak diren hormonek bullying jokabidearekin zuten harremana aztertzea izan zen. Helburu hau abiapuntu izanik Populazioa, Esposizioa, Konparatzailea, Emaitzak eta Ikerketa Diseinua (PECOS: Population, Exposure, Comparator, Outcomes and Study Design) aintzat hartzen zituen ikerketa galdera planteatu zen. Ingeles jatorria duen galdera hau ikerketaren helburuak definitzeko eta, berrikuspen sistematikoaren oinarri izateko erabilgarria da (Morgan et al., 2018):

- ***Populazioa:*** Eskola adineko haurrak (6-12 urte) edo nerabeak (12-18 urte).
- ***Esposizioa:*** HPA eta HPG ardatzen menpeko hormonak.
- ***Konparatzailea:*** Gorputzeko beste faktore biologiko batzuk.
- ***Emaitzak:*** Bullyinga edo eskola jazarpena.
- ***Ikerketa diseinua:*** Behaketa ikerketak edo interbentziokoak.

Ikerketa galdera formulatu ostean, aldagaien definizioa eta aukeraketa egin zen. HPA eta HPG ardatzetako hormonak aztergai izanik, termino desberdinak erabili ziren hauek bilatzeko:

"hormone", "GnRH", "CRH", "ACTH", "LH", "FSH", "testosterone", "estradiol", "cortisol", "dehydroepiandrosterone", "2d:4d ratio", "HPA" eta "HPG". Eskola jazarpenari erreferentzia egiteko ere termino desberdinak erabili ohi izan direnez, sinonimo desberdinak erabiliz egin zen bilaketa: "bullying", "victimization", "peer victimization", "school violence". Azkenik, populazioari erreparatuz "children", "preadolescents" eta "adolescents" terminoak erabili ziren. Terminoak hautatu ondoren, bilaketa estrategia definitu zen AND, OR eta NOT operatzaile boolearrak erabiliz. Gainera, bilaketak egiteko iragazkiak zehaztu ziren: hizkuntza (ingelesa eta gaztelania) eta urteak (azken 20 urteak). Bilaketa hiru datu base desberdinetan egin zen 2022ko maiatzaren 22tik 2022ko ekainaren 12 bitartean: PubMed, Web of Science (WoS) eta PsycInfo.

Berrikuspenaren parte izango ziren artikuluak aukeratzeko inklusio eta baztertze irizpideak zehaztu ziren (2. taula):

2 Taula

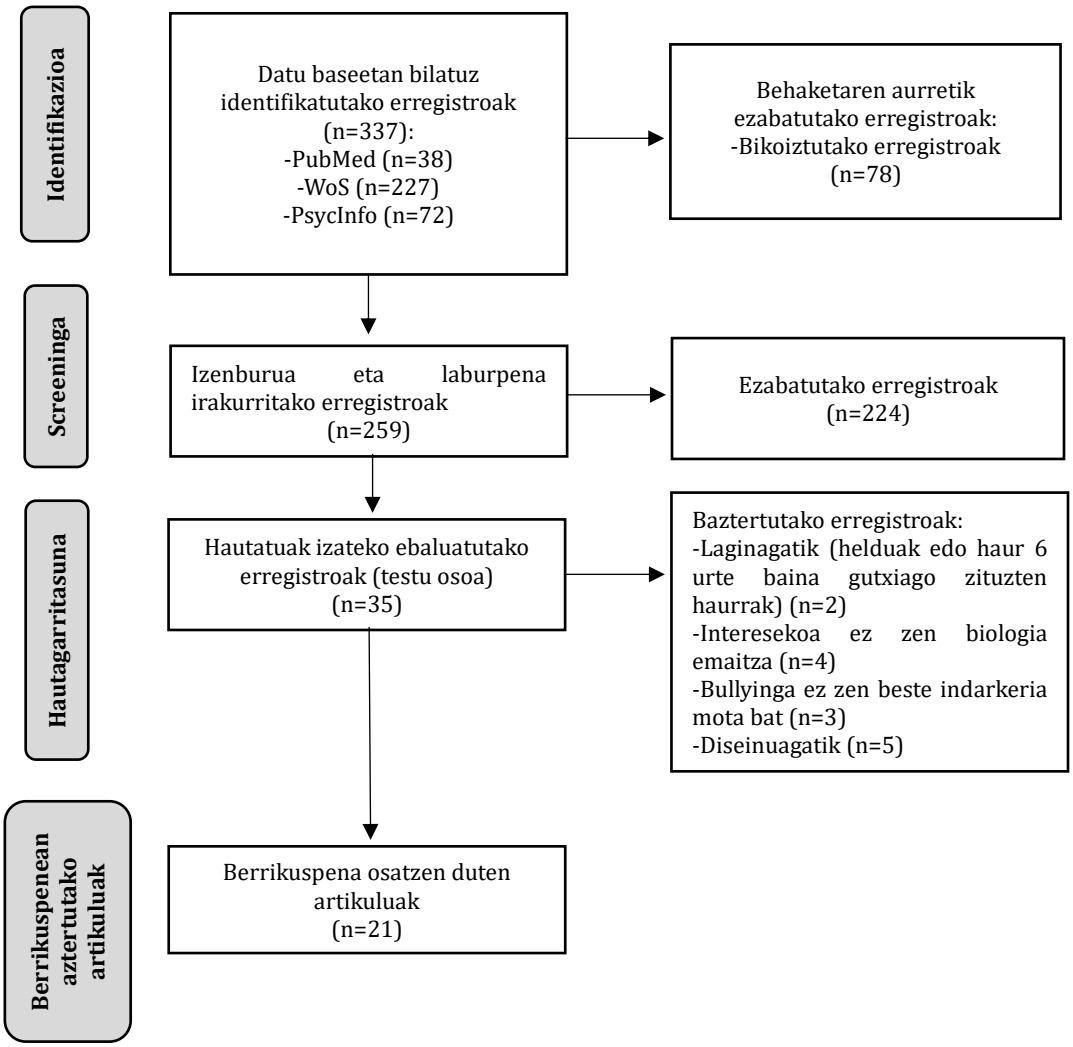
Berrikuspen sistematizatuaren inklusio eta baztertze irizpideak

Inklusio-irizpideak	Baztertze-irizpideak
-HPG eta HPA ardatzen menpekoak diren hormonen eta eskola jazarpenaren arteko harremana aztertzen duten lanak. -Partaideak 6-18 urte arteko haur edo nerabeak izatea. -Ikerketa artikuluak.	-Beste faktore biologiko batzuk aintzat hartzen dituzten lanak. -Eskola jazarpena ez den beste indarkeria batzuk aztertzen dituzten lanak. -Partaideak <6 urte baino gutxiago dituzten haurrak edo helduak izatea. -Tesiak edo publikatu gabeko lanak.

Bilaketak guztira 337 artikulu igorri zituen eta bikoiztutako lanak ezabatu ostean, 259 erregistro aztertu ziren. Lanen izenburua eta laburpena ebaluatu ondoren, 35 artikuluren testu osoa aztertu zen. Hauetatik, 21 hautatu ziren lan honetan azaltzen den berrikuspena osatzeko (4. irudia).

4 Irudia

Berrikuspen sistematizatuaren fluxu-diagrama



2.6.2.1. Berrikuspena Osatzen Duten Artikuluen Deskribapena. Berrikuspen honetako lanetan oinarrituz, HPA eta HPG ardatzek bullying jokabidearekin duten harremana aztertzen da (3. taula).

Aztertutako lanetatik zortzi Ameriketako Estatu Batuetan (n=8; %38), zazpi Europan (n=7; %33), bost Kanadan (n=5; %24) eta bat Txinan (n=1; %5) garatu ziren. Artikuluen erdia baina gehiago (n=13; %62) azken 10 urteetan argitaratu da (2012-2022). Diseinuari erreparatuz, hamaika zeharkako ikerketak ziren (n=11; %52) eta hamar, aldiz, luzerako ikerketak (n=10; %48). Laginari dagokionez, tamaina txikiena erabili zuen lanak 31 pertsona aztertu zituen, gehien aztertu zituenak, berriz, 556 partaideen datuak erabili zituen (Ouellet-Morin et al., 2021a; Ouellet-Morin et al., 2021b; Williams et al., 2017).

Ikerketa aldagaiak ebaluatzeko ere material eta teknika desberdinak erabili ziren. Hormona mailei dagokionez, ikerketa bakar batek neurtu zituen testosterona mailak (n=1; %5), horretarako listu laginak erabiliz. Beste ikerketa guztiek kortisol mailak ebaluatu zituzten (n=20; % 95). Hauetatik, gehienek listu laginak erabili zituzten (n=19; %90) eta, bi ikerketek, aldiz, ileko laginak erabili zituzten (n=2; %10). Listuko hormona mailek momentuko informazioa eskaintzen duten bitartean, ilean hormona mailak neurtzeak azken hilabeteetan pilatutako hormonei buruzko informazioa izatea ahalbidetzen du. Listuko kortisol mailak neurtzeak neurri desberdinak lortzea errazten du: kortisolaren erreaktibotasuna (estresatzaile baten aurrean

kortisolak duen erantzuna), kortisol maila totalak, esnatzerakoan kortisolaren erantzuna (CAR: Cortisol Awakening Response), kortisolaren erritmoa edo kortisolaren eguneko malda. Neurri desberdin hauek eskaintzen duten informazioa interpretatzeko ezinbestekoa da kortisolak jarraitzen duen eguneko zikloa ulertzea. Aurretik aipatu den modura, kortisol mailek goizean, esnatu eta 30 minutura gutxi gora behera, igoera bat jasaten dute. Horri, kortisolaren erantzuna esnatzean deitzen zaio edo "cortisol awakening response (CAR)" ingelesez. Igoera honen ostean kortisol mailak progresiboki gutxituz doaz egunean zehar eta maila baxuenak lotan hasi ostean aurkitzen dira.

Eskola jazarpenaren ebaluazioari dagokionez lan gehienek galdetegiak erabili zituzten (n=17; %81), hiru artikuluetan, ordea, biktimizazioa elkarrizketa bidez ebaluatu zen (n=3; %14) eta batean berdinen arteko izendapenak erabili ziren (n=1; %5).

2.6.2.2. Sexu Hormonek Bullyingarekin Duten Harremana. Gure gorputzeko hormonek nerbio sistema zentralean (NSZ) eragina izan dezakete, batik bat, garapeneko bi momentutan: jaio aurreko garaian eta nerabezaroan (Schulz et al., 2009; Sisk & Foster, 2004; Sisk & Zehr, 2005). Garapeneko momentu hauetan sexu hormonek garuneko zenbait egituratan eragin dezakete (Sisk & Zehr, 2005) jokabideaz arduratzen diren zirkuitu neuralak antolatuz eta zirkuitu neuroendokrinoak aktibatuz (Adolphs, 2002; Berenbaum & Beltz, 2011).

Phoenix et al. (1959) lehenengoak izan ziren androgenoekiko esposizio goiztiarrak jokabidearekin zuen erlazioa ikertzen.

Animaliekin egindako lan batean jaio aurreko testosterona mailek jokabidea antolatzen zuten ehun neuraletan eragiten zuela aurkitu zuten. Gizakiotan, jaio aurreko sexu hormona mailak zuzenean neurtzeak amniozentesia deritzon teknika inbaditzaile bat erabiltzea eskatzen du. Modu ez inbaditzailean jaio aurreko sexu hormona mailak ezagutzeko asmoz, 2D:4D indizea proposatu zen. Indize honen balio baxuagoak jaio aurreko testosterona maila altuagoen erakusle dira (Mikac et al., 2016). Indize honek zuzenean likido amniotikoan neurturiko hormonekin zuen harremana lehen aldiz Lutchmaya et al.-ek (2004) erakutsi zuten, harreman hau estatistikoki esanguratsu izanik indizea eskuineko eskuetan neurtzean soilik. Urte batzuk geroago Ventura et al.-ek (2013) testosterona eta 2D:4D indizearen arteko harremana frogatu zuten, baina soilik nesketan. Aitzitik, harreman hau aurkitu ez duten ikertzaileak ere badaude (Hollier et al., 2015; Richards et al., 2021). Nahiz eta emaitzak nahiko nahasiak izan, egun, 2D:4D indizea jaio aurreko sexu hormona mailen indikatzaile gisa erabiltzen da eta zenbait jokabiderekin erlazioa duela erakutsi du, besteak beste, agresibitatearekin. Meta-analisi baten datuek, 2D:4D indizea eta agresibitatearen arteko asoziazioa estatistikoki esanguratsua eta txikia zela erakutsi zuten (Hönekopp & Watson, 2011). Bullyingari dagokionez, tesian egindako berrikuspenaren arabera, egun arte 2D:4D indizea eta bullying jokabidearen arteko harremana aztertu duen lanik ez dago.

Aurretik, sexu hormonek pubertaro garaian eragina izan dezaketela aipatu da. Pubertaro garaiko testosterona mailen eta agresibitatearen arteko harremanak ikertzen dituzten lan gehienek

testosterona maila altuak agresibitate gehiagorekin lotzen direla ikusi dute (Archer et al., 2005; Geniole et al., 2020; Grotzinger et al., 2018; Sánchez-Martín et al., 2011).

Eskola jazarpenari dagokionez, ordea, berrikuspen sistematizatuaren emaitzek hormona honek bullyingarekin zuen lotura aztertzen zuen lan bakarra zegoela erakutsi zuten. Ikerketa honek bullying biktimizazioa eta testosteronaren arteko harremana sexuaren menpekoa zela erakutsi zuen. Bullyinga jasaten zuten neskek testosterona maila baxuagoak zituztela ikusi zen, aldiz, mutilek testosterona maila altuagoak zituzten (Vaillancourt et al., 2009).

2.6.2.3. Kortisolak Bullyingarekin Duen Harremana. Klasikoki, hipotesi dualaren arabera, HPA eta HPG ardatzen artean erlazio inhibitzaileak ematen dira. Hau da, testosterona altua eta agresibitate maila altuen arteko harremana ematen denean, kortisol mailak baxuak direla ikusi da (Mehta & Josephs, 2010). Hau helduen kasuan horrela izanik ere, haur eta nerabeetan egin diren ikerketek emaitza kontraesankorrak erakutsi dituzte. Ikerketa gehienek kortisol eta agresibitate mailen artean lotura negatiboa erakutsiz (McBurnett et al., 2000; Oberle et al., 2017; Oosterlan et al., 2005; Shoal et al., 2003; van de Wiel et al., 2004), eta bakar batzuk erlazio positiboa topatuz (Azurmendi et al., 2016; Barzman et al., 2013). Beste ikertzaile batzuk ondorioztatu dute sistema adrenalak estimulu estresagarriekiko sentiberatasuna areagotzen duela eta, ondorioz, agresibitatearen erantzun bat erraztu dezakeela (Moya et al., 2016).

Bestalde, kortisol mailak, haur eta nerabeek jasaten duten indarkeriarekin ere erlazionatu dira. Indarkeria edo abusu egoerak estresatzaileak direnez, gorputzak egoera hauen aurrean HPA ardatza aktibatzen du, eta ondorioz, kortisol mailen igoera gauzatu dezake (Vanaelst et al., 2012). Indarkeria edo abusu egoera hori epe luzean mantentzen bada, estres kronikoa bilakatuko da, glukokortikoide gehiegi eraginez, edo beste kasu batzuetan, kortisol mailak kontrolatze aldera, HPA ardatzaren inhibizioa emanez.

Eskola jazarpena, haurtzaro eta nerabezaroan zehar ematen den agresibitate-abusu egoera bat denez, bullyingak HPA ardatzaren aktibitate disruptiboan duen eragina aztertua izan da. Hala ere, kortisola eta bullyingaren arteko harremana aztertu zuen berrikuspen sistematiko batek ez zuen norabide argirik erakutsi (Kliewer et al., 2019). Tesi honen parte den berrikuspen sistematizatuak kortisola eta eskola jazarpenaren arteko harremana lantzen duten ikerketa desberdinak daudela erakutsi du. Lan hauetan kortisola ondorio gisa ikertu da eta hormona hau determinatzeko neurri eta teknika desberdinak erabili dira.

Esperimentalki estres sozialaren aurrean kortisolak duen erreaktibitatea neurtu zuten lan gehienek biktimak ziren haur edo gazteek kortisolaren erreaktibitate txikiagoa zutela aurkitu zuten (Bendezú et al., 2022; Calhoun et al., 2014; Kliewer, 2016; Knack, et al., 2011; Ouellet-Morin et al., 2011a; Ouellet-Morin et al., 2011b). Bi lanek, ostera, eskola jazarpena jasaten zuten haur eta nerabeek kortisolaren erreaktibitate handiago bat zutela erakutsi zuten

(Chen et al., 2018; Kliewer, 2006). Azkenik, Kliewer et al.-ek (2012) beren lanean ez zuten erlazio estatistikoki esanguratsua zen erlaziorik aurkitu kortisola eta berdinen arteko biktimizazioaren artean.

Kortisol maila totalari dagokionez, zenbait ikerketek erabateko jazarpena jasaten duten ikasleen edo berdinengatik baztertuak diren haurren kortisol mailak altuagoak direla frogatu zuten (Chen et al., 2018; González-Cabrera et al., 2017; Peters et al., 2011). Ildo beretik, González-Cabrera et al.-ek (2017) bere lanean ziberbiktimaz gain ziberbiktima-zibererasotzaileek ere kortisol maila altuagoak zituztela ikusi zuten. Bestalde, Carney et al.-ek (2010) kortisol maila totalak biktima izatearekin ez zirela erlazionatzen aurkitu zuen.

Kortisolaren esnatzeko erreakzioa (CAR) aztertzen duten lan batzuk ere badaude. Bi lanek eskola jazarpena jasaten zuten partaideek goizeko erantzun baxuago bat zutela ondorioztatu zuten (Knack et al., 2011; Östberg et al., 2018) eta aldiz, beste batzuk ezin izan zuten erlazio hau baieztatu (Brendgen et al., 2017; Du Plessis et al., 2019; González-Cabrera et al., 2017).

Beste lan batzuk, eskola jazarpenaren biktimak ziren haur eta nerabeek kortisolaren eguneko malda lauagoak zituztela ondorioztatu zuten (Brendgen et al., 2017; González-Cabrera et al., 2017; Knack et al., 2011; Peters et al., 2011). Kontrako ildotik, bi lanek ez zuten kortisolaren eguneko malda edo eguneko erritmoa eta biktimizazioaren arteko harremana aurkitu (Du Plessis et al., 2019; Williams et al., 2017).

Azkenik, biktimizazioa eta kortisolaren arteko harremana sexuaren menpekoa dela baieztatu dute ikertzaile batzuk. Vaillancourt et al.-ek (2008), hitzezko eskola jazarpena jasaten zuten neskek kortisol maila baxuagoak zituztela erakutsi zuten, mutilek, berriz, kortisol maila altuagoak. Halaber, Östbergek (2018) eskola jazarpena jasaten zuten ikasleek kortisol maila baxuagoak eta erantzun lauagoak zituztela aurkitu zuen, harreman hau soilik mutiletan izanik estatistikoki esanguratsua.

Amaitzeko, nahiz eta ikerketa gehienek kortisola listuan neurtu duten, bi ikerketek, ileko kortisol kontzentrazioak neurtu zituzten. Hauetatik batek erakutsi zuen nahiz eta metatutako biktimizazioa (ezbehar sozioekonomiko eta psikosozialak) ileko kortisolarekin erlazionatu, berdinen arteko biktimizazioa ez zela zuzenean ileko kortisolarekin lotzen (Ouellet-Morin, et al., 2021b). Beste lanak, ostera, biktimizazio maila desberdinak ileko kortisolean eragiten zuela ondorioztatu zen. Zehazki, moderatua pairatzen zuten ikasleek ileko kortisol baxuagoa erakutsi zuten, biktimizazio maila altua jasaten zutenek aldiz, ileko kortisol kontzentrazio altuagoak erakutsi zituzten. Harreman hauek soilik mutiletan ziren estatistikoki esanguratsuak (Ouellet-Morin, et al., 2021a).

2.6.3. Pubertaro edo Nerabezaro Garaian Ematen diren Berezitasunak

Pubertaroa edo nerabezaroa aldaketa ugariz beteriko garaia da. Alderdi biologikoari erreparatuz, garai honetan gizabanakoaren garapenean beharrezkoak diren aldaketak ematen dira. Garai honetan zehar HPA eta HPG ardatzak garapen fasean aurkitzen dira,

eta ondorioz, bi ardatzen menpekoak diren hormonek, besteak beste, testosteronak eta kortisolak igoera bat jasan ohi dute. Hori dela eta, nahiz eta garapeneko beste fase batzuetan bi ardatz hauek batak besteari atzeraelikadura negatiboaren bitartez eragin, pubertaro garian, ardatz hauek garapen fasean aurkitzen direnez, ardatz batek ez du bestea inhibituko (Ruttle et al., 2013).

Hormonen eraldaketa honek pertsonen garapen fisikoan ez ezik alderdi psikologikoan eta jokabidean eragina izango du. Aurretik aipatu bezala gure gorputzeko hormonek garapen fase honetan garuneko zenbait egitura antolatu ditzakete eta, hortaz, hauen menpekoak diren jokabideetan eraginak izan.

Eskola jazarpena, nerabezaro garaian ematen da, batik bat, 11-14 urte bitarte. Bullying prebalentzia altuena lehen hezkuntzatik bigarren hezkuntzarako trantsizio garaian gertatu arren, nerabezaroko urteetan zehar aldatuz doala ikusi da. Espainiako datuekin egindako ikerketa batean, bullying prebalentzia altuena nerabezaro erdian (14-17 urte bitarte) ematen zirela ikusi zen, aldiz, kasu larrienak nerabezaro goiztiarrean (11-13 urte bitarte) aurkitzen ziren (González-Cabrera et al., 2022).

3 Taula

HPG eta HPA ardatzek bullyingarekin duten harremana aztertzen duten lanen laburpena

Autoreak (urtea)	Ikerketaren helburua	Lagina (Herrialdea, partaide kopurua, adina urteetan)	Ikerketa diseinua	Aldagai biologikoa	Bullyinga ebaluatzeko tresna	Emaitza esanguratsuak
Kliewer (2006)	Berdinen biktimizazioak listuko kortisol mailekin zuen harremana aztertzea.	Ameriketako Estatu Batuak (AEB) N=101 *Adina:*11,14 (1,28)	Z	Kortisola listuan (kortisolaren erreaktibitatea eta CAR)	Berdinen arteko biktimizazioa: *Adolescent Resource Challenges Scale (ARCS)* eskalan oinarritua. *Denbora-tartea:* azken 18 hilabeteak.	-Berdinen arteko biktimizazioa kortisol basal maila baxuekin erlazionatzen zen. -Berdinen biktimizazioa kortisol mailen igoerarekin (laborategiko jarduera aurretik laborategiko jarduera ostera) erlazionatzen zen.
Vaillancourt et al. (2008)	Berdinen arteko biktimizazioa eta kortisolaren arteko harremana aztertzea.	Kanada N=154 *Adina:*12,25 (0,76)	Z	Kortisola listuan (kortisol totala)	Bullying biktimizazioa: *Olweus Bully Victim Questionnaire (OBVQ)* galdetegian oinarritua. *Denbora-tartea:* azken hiru hilabeteak.	-Kortisola eta biktimizazioaren arteko erlazioa sexuaren menpekoa da. -Hitzezko biktimizazioa noizbehinka jasaten zuten neskek kortisol maila baxuagoak zituzten. -Hitzezko biktimizazioa noizbehinka jasaten zuten mutilek kortisol maila altuagoak zituzten.

Vaillancourt et al. (2009)	Listuko testosterona eta berdinen biktimizazioaren arteko erlazioa aztertzea nerabezaro goiztiarreko neska eta mutiletan.	Kanada N=151 *Adina:* 12,7 (0,74)	Z	Testosterona listuan	Bullying biktimizazioa: *Olweus Bully Victim Questionnaire (OBVQ)* galdetegian oinarritua. *Denbora-tartea:* azken hiru hilabeteak.	-Testosterona eta biktimizazioaren arteko harremana sexuaren menpekoa zen. -Hitzezko biktimizazioa jasaten zuten neskek testosterona maila baxuagoak zituzten biktimak ez ziren berdinekin alderatuz. -Hitzezko biktimizazioa jasaten zuten mutilek testosterona maila altuagoak zituzten biktimak ez ziren mutilekin alderatuz.
Carney et al. (2010)	Bullyingarekiko esposizioak HPA ardatzaren aktibitatearekin duen lotura aztertzea.	AEB N=91 *Adina:* 11,5 (11-14)	Z	Kortisola listuan (kortisol totala)	Bullyingarekiko esposizioa: *Bullying Survey (SBS)*-eko 2 item. *Denbora-tartea:* azken urtea.	-Bullyingarekiko esposizioa ez zen zuzenki kortisol mailekin erlazionatu. -Bullying esposizio altuagoa kortisol maila baxuagoekin erlazionatzen zen agresibitate orokortuaren bitartez.
Ouellet-Morin et al. (2011a)	Esperientzia estresagarri goiztiarrek estresaren erantzun fisiologikoan duten efektua aztertzea.	Erresuma Batua N=60 (30 biki pare) *Adina:*12,53 (0,52)	Z	Kortisola listuan (erreaktibitatea)	Bullying biktimizazioa: elkarrizketa bitartez. *Denbora-tartea:* bizi-historia.	-Jazarpena jasaten zuten bikiek kortisolaren erantzun arinduago bat zuten.
Ouellet-Morin et al. (2011b)	Indarkeria edo biktimizazioa jasaten zuten haurrek estres psikosozialaren aurrean	Erresuma Batua N=190 *Adina*: 12	L	Kortisola listuan (erreaktibitatea)	Indarkeria eta bullying biktimizazioa: elkarrizketa bitartez.	-Biktimizazioa edo indarkeria jasan zuten ikasleek, kortisol

	zuten kortisolaren erantzuna aztertzea.				*Denbora-tartea:* bizi-historia.	maila baxuagoak zituzten test psikosozialaren ostean.
Knack et al. (2011)	Bullyingak kortisol mailatan eragiten duen aztertzea.	AEB N=107 *Adina:*12,23 (1,09)	L	Kortisola listuan (erreaktibitatea, CAR, eguneko malda)	Berdinen arteko biktimizazioa: *Children's self-experiences questionnaire (CSEQ*) galdetegia. *Denbora-tartea:* ez da zehazten.	-Biktimizazioa jasaten zuten nerabeek kortisol maila baxuagoak erakusten zituzten jaiki eta 30 minutu ostean eta ohera joan aurreko 30 minututan. -Biktimak ziren nerabeek test sozialaren aurrean kortisolaren erreaktibitate baxuago bat erakutsi zuten.
Peters et al. (2011)	Berdinen arteko biktimizazioak eta berdinen arteko baztertzeak HPA aktibitatearekin duen harremana aztertzea.	Herbehereak N=129 *Adina*: 9,27 (0,20)	Z	Kortisola listuan (eguneko malda, kortisol totala)	Berdinen arteko biktimizazioa eta baztertzea: berdinen arteko izendapenak.	-Berdinengatik baztertuak ziren haurrek kortisol maila altuagoak zituzten eskolan. -Berdinengatik baztertuak ziren haurrek kortisol malda lauagoak zituzten.
Kliewer et al. (2012)	Berdinen biktimizazio eta agresibitate esperientziek aldagai fisiologikoekin duten erlazioa aztertzea.	AEB N=228 *Adina:* 14,1 (1,6)	L	Kortisola eta alfa amilasa listuan (erreaktibitatea)	Berdinen arteko biktimizazioa: *Social Experience Questionnaire (SEQ)* galdetegia. *Denbora-tartea:* azken 30 egunak.	-Biktimizazioa nerbio sistema sinpatikoaren aktibitatearekin, hots, alfa amilasarekin erlazionatu zen. Zehazki, biktimizazioa jasaten zuten nerabeek jarduera estresagarri baten aurrean alfa amilasaren igoera bat zutela ikusi zen.

						-Kortisolak biktimizazioaren aurrean zuen erreaktibotasuna ez zen frogatu.
Ouellet-Morin et al. (2013)	Bullying biktimizazioak SERT DNA metilazioan zuen eragina aztertzea eta DNA metilazioak kortisolarekin zuen lotura aztertzea.	Erresuma Batua N=56 (28 biki pare) *Adina:* 12 urte	L	Kortisola listuan (erreaktibitatea), DNA metilazioa (ahoko zelulekin)	Bullying biktimizazioa: elkarrizketa bitartez. *Denbora-tartea:* bizi-historia.	-Biktimizazioa jasaten zuten bikiek SERT DNA metilazio altuagoa zuten. -SERT DNA metilazio handiagoa zuten haurrek, kortisol erantzun lauago bat zuten estres psikosozialaren jardueraren aurrean. -Biktimizazioa jasaten zuten bikiek kortisol maila baxuagoak zituzten estres jardueraren aurrean.
Calhoun et al. (2014)	Biktimizazioa, laguntasuna eta HPA erreaktibitatearen arteko erlazioa aztertzea test psikosozial baten aurrean.	AEB N=62 *Adina*:14,70 (1,33)	Z	Kortisola listuan (erreaktibitatea)	Berdinen arteko biktimizazioa: *Revised Peer Experiences Questionnaire* galdetegia. *Denbora-tartea:* azken urtean.	-Biktimizazio altua jasaten zuten nerabeek kortisolaren erantzun baxuago bat zuten estres psikosozialaren testaren aurrean. -Lagunen kalitate positiboa kortisol maila baxuagoekin erlazionatzen da.
Kliewer (2016)	Bullying biktimizazioak alfa amilasa eta kortisol mailekin duen lotura aztertzea eta harreman honetan emozioen	AEB N=242 *Adina:*11,98 (1,56)	L	Kortisola eta alfa amilasa listuan (erreaktibitatea)	Berdinen arteko biktimizazioa: *Survey of Children's Exposure to Violence* tresna.	-Biktimizazioa estres jardueraren aurrean kortisolaren erantzunekin modu negatiboan erlazionatzen zen.

	erregulazioak duen moderatzaile rola aztertzea.				*Denbora-tartea:* azken urtea.	-Biktimizazioa eta alfa amilasaren artean ez zen estatistikoki esanguratsua zen harremanik aurkitu.
Brendgen et al. (2017)	Ikaskideen biktimizazioak eta guraso eta ikaskideekin harremanen kalitateak kortisolarekin duten erlazioa aztertzea.	Kanada N=272 (136 biki pare) *Adina:* 14,07 (0,30)	L	Kortisola listuan (eguneko malda, CAR)	Berdinen arteko biktimizazioa: *Social Experience Questionnaire (SEQ)* galdetegiaren bitartez. *Denbora-tartea:* azken eskola urtea.	-Biktimizazio gehiago jasaten zuten bikiek, beren bikiek baino jaitsiera handiagoa pairatu zuten kortisolaren eguneko maldetan. -Aldiz, amarekin harreman okerrago bat zuten bikiek kortisol erantzun handiago bat zuten.
Williams et al. (2017)	Nerabeen eskola jazarpenaren, kortisolaren eta depresioaren sintomen arteko erlazioak aztertzea.	AEB N=31 *Adina:*14,5 (6,7)	Z	Kortisola listuan (eguneko erritmoa)	Bullying biktimizazioa: *Personal Experience Checklist (PECK)* tresna bitartez. *Denbora-tartea:* azken hilabetea	-Ez zen korrelaziorik aurkitu kortisola eta biktimizazioaren artean.
González-Cabrera et al. (2017)	Cyberbullyingak kortisol mailekin duen lotura aztertzea.	Espainia N=60 *Adina:* 15,58 (1,12)	L	Kortisola listuan (eguneko malda, CAR, kortisol totala)	Cyberbullyinga: Garaigordobilen eskala. *Denbora-tartea:* ez da zehazten.	-Cyberbiktima larriek kortisol kurba lauagoak zituzten. -Cyberbiktima eta cyberbiktima-cybererasotzaileek kortisol sekrezio handiagoa zuten orokorrean.
Östberg et al. (2018)	Bullyingak estresatzaile gisa jokatzen duen papera aztertzea eta	Suedia N=392 *Adina:* 14-16	Z	Kortisola listuan (CAR, eguneko malda)	Bullying biktimizazioa: *ad hoc* galdetegia.	-Biktimizazioa jasaten zuten ikasleek kortisol maila baxuagoak eta CAR baxuagoa zuten,

	kortisol mailekin duen harremana ikertzea.				*Denbora-tartea:* ez da zehazten.	harreman hau soilik mutiletan izanik estatistikoki esanguratsua.
Chen et al. (2018)	Kortisol mailak bullying biktimizazioa jasaten zuten eta jasaten ez zuten haurren artean nola desberdintzen ziren aztertzea.	Txina N=80 *Adina:*10,83 (0,70)	Z	Kortisola listuan (erreaktibitatea, kortisol totala)	Bullying biktimizazioa: *Olweus Bully Victim Questionnaire (OBVQ)* galdetegiko 6 item. *Denbora-tartea:* azken sei hilabeteak.	-Biktimizazioa jasaten zuten haurrek kortisol maila altuagoak erakusten zituzten esperimentalki kontrolatutako estres sozialaren ondoren. -Kortisol totala altuagoa zen biktimizazioa jasaten zuten haurretan.
Du Plessis et al. (2019)	HPA ardatzak bullying eta garuneko egituren artean moderatzaile rola aztertzea nerabeetan.	Herbehereak N=118 *Adina:* 9,29 (0,37)	L	Kortisola listuan (CAR, eguneko malda)	Bullying biktimizazioa: *Olweus Bully Victim Questionnaire (OBVQ)* galdetegia. *Denbora-tartea:* azken eskola urtean.	-Biktimizazioa eta kortisol mailen artean ez zen harreman esanguratsurik aurkitu.
Ouellet-Morin et al. (2021a)	Berdinen arteko biktimizazioak ileko kortisol mailekin zuen harremana aztertzea eta harreman hau sexuaren, denboraren eta esposizioaren arabera aldakorra zen ikustea.	Kanada N=556 *Adina:* 17	L	Kortisola ilean (lehen 3 cm)	Berdinen arteko biktimizazioa: *Self Report Victimization* escalatik moldatua. *Denbora-tartea:* Eskola ikasturtean zehar.	-Biktimizazio moderatua jasaten zuten mutilek, kortisol maila baxuagoak zituzten ilean. -Biktimizazio altua jasaten zuten mutilek, biktimak ileko kortisol kontzentrazio altuagoak zituzten.
Ouellet-Morin et al. (2021b)	Metatutako ezbehar sozioekonomiko eta psikosozialaren indize	Kanada N=556 *Adina:* 17	L	Kortisola ilean (lehen 3 cm)	Berdinen arteko biktimizazioa: *Self*	-Metatutako ezbeharrek kortisol mailekin zuten erlazioa U formakoa zela ikusi zen. Ezbehar

	bat (haurtzarotik nerabezarorarte), ile-kortisolaren kontzentrazioekin lotzen zen aztertzea.				*Report Victimization* eskalatik modatua. *Denbora-tartea:* Eskola ikasturtean zehar.	maila txikia eta handia zuten gazteek kortisol maila moderatu-altuak zituzten. Aldiz, ezbehar ertainen eraginpean zeuden gazteek kortisol maila txikiagoak zituzten. -Berdinen arteko biktimizazioa ez zen estatistikoki modu esanguratsuan erlazionatu ileko kortisol mailekin.
Bendezú et al. (2022)	Kortisol eta zitokina proinflamatorio mailek berdinen arteko tentsioarekin eta biktimizazioarekin duten lotura aztertzea.	AEB N=157 *Adina:* 14,72 (1,38)	Z	Kortisola listuan eta zitokina proinflamatorioak (erreaktibitatea)	Berdinen arteko tentsioa eta biktimizazioa: *Revised Peer Experiences Questionnaire (RPEQ)* galdetegia. *Denbora-tartea:* ez da zehazten.	-Kortisol maila baxuak eta zitokina profil egonkor altua zituzten nerabeek pubertaro aurreratuago bat zuten eta probabilitate gehiago erakutsi zuten berdinen arteko tentsioa eta berdinen arteko biktimizazioa jasateko.

Oharra: L= Luzerako ikerketak, Z= Zeharkako ikerketak.

3. Hipotesiak eta Helburuak

Tesi honen helburu nagusia eskola jazarpena ikuspegi biopsikosozial batetik ikertzea izan zen. Zehatzago esanda, jaio aurreko eta pubertaro aurreko hormona mailek eta gizabanakoaren eta honen testuinguruko aldagaiek bullyingarekin zuten lotura aztertzea bilatu zen. Helburu hau abiapuntu izanik zenbait hipotesi (Hi), helburu orokor (H.O) eta helburu espezifiko (H.E) planteatu ziren.

3.1. Hipotesiak

Hi.1: Gizabanakoaren, familiaren, eskolaren eta komunitatearen menpekoak diren aldagaiek eskola jazarpenean eragingo dute. Zehazki, portaera arazoak izatea, funtzio exekutibo ahulagoak izatea edota gertaera estresagarriak bizi izanak bullyingean inplikatua izateko arriskua areagotzea espero da. Aldiz, aurrenerabeen familiarekin (maila sozioekonomiko altua, ikasketa maila altua, familia testuinguru egokia), eskolarekin (eskola inguruaren hautemate egokia eta ikaskideekin harreman ona), nahiz komunitatearekin (bizilagunengan fidagarritasuna eta sostengu soziala hautematea) erlazioa duten faktoreek bullyingaren babes faktore gisa jardungo dutela espero da.

Hi.2: 2D:4D indizea, pubertaro aurreko hormona mailak eta aldagai psikosozialak elkarlanean jardungo dute aurrenerabeek eskola jazarpenean hartu ditzaketen roletan (biktima, erasotzaile, erasotzaile-biktima). Hormona mailei dagokionez, 2D:4D indize baxuagoa, pubertaro aurreko testosterona maila altuak eta kortisol

maila baxuak bullying inplikazioarekin erlazionatzea espero da. Faktore psikosozialei dagokionez, funtzio exekutibo ahulagoak izatea, sostengu sozial eskasa izatea eta familia nahiz eskola testuinguru okerrago bat hautematea bullyingean parte hartzeko arriskua handituko dute.

Hi.3: Eskola inguruarekin erlazioa duten zenbait faktorek haurren estres kroniko mailetan eragitea, eta beraz, kortisolarekin erlazionatzea espero da. Zehazki, eskola ingurua okerrago hautematea, berdinekin arazoak izatea, eskola errendimendu baxuago bat izatea eta bullyingean parte hartzea (biktima, erasotzaile edo erasotzaile-biktima izatea) kortisol maila altuagoekin erlazionatzea espero da.

3.2. Helburuak

3.2.1. Helburu Orokorrak

H.O.1: Bullying fenomenoaren prebalentzia estimatzea Gipuzkoa eta Sabadelleko 11 urteko aurrenerabeetan.

H.O.2: Bullying jokabidean arrisku nahiz babes faktore gisa eragiten duten eta gizabanakoarekin, familiarekin, eskola inguruarekin eta komunitatearekin erlazioa duten aldagaiak identifikatzea.

H.O.3: Hormona mailek (2D:4D indizea eta listu laginen bitartez neurtuak) eta faktore psikosozialek eskola jazarpenean duten elkarreragina aztertzea.

H.O.4: Eskolaren menpeko aldagaiek (errendimendu akademikoa, eskola ingurua, berdinekin harremana) eta bullyingak estres kronikoan (ileko kortisol mailetan) duten efektua aztertzea.

3.2.2 Helburu Espezifikoak

H.E.1: Gizabanakoaren menpekoak diren zenbait aldagaik (portaera arazoak, funtzio exekutiboa, arreta, ongizatea, bizi gertaera estresagarriak) bullying rolekin (biktima, erasotzaile, erasotzaile-biktima) duten erlazioa aztertzea.

H.E.2: Aurrenerabeen familia ezaugarriekin (familia egitura, gurasoen maila sozioekonomiko eta ikasketa mailak, familia testuingurua) lotura duten aldagaiek bullyingean arrisku nahiz babes faktore gisa duten papera aztertzea.

H.E.3: Aurrenerabeen eskola faktoreek (eskola mota, ikasle kopurua, berdinekin harremanak, eskola inguruaren hautematea) eskola jazarpenarekin duten erlazioa ikertzea.

H.E.4: Komunitateko zenbait ezaugarrik (bizilagunengan fidagarritasuna eta sostengu soziala) bullying jokabidean duten eragina ikustea.

H.E.5: Jaio aurreko sexu hormonek (2D:4D indizearekin neurtuta) eta pubertaro aurreko hormona mailek (testosterona, kortisola) bullying jokabideko rol desberdinetan duten eragina aztertzea.

H.E.6: Hormona mailen eta aldagai psikosozialen arteko harremanak ezagutzea.

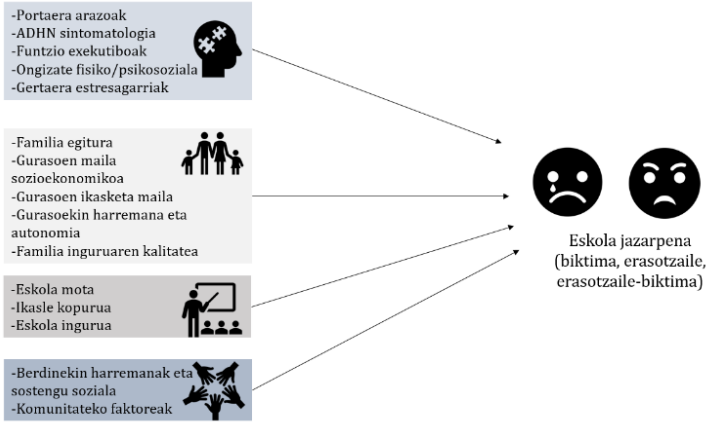
H.E.7: Eskola inguruko faktoreek, hots, aurrenerabearen errendimendu akademikoak, honek berdinekin dituen harremanak, eskola inguruarekiko duen pertzepzioak eta, bullyingean duen rolak kortisol mailarekin duten lotura ikertzea.

H.E.8: Aurrenerabeen funtzio exekutiboek eskolaren menpeko aldagaiekin, bullyingarekin eta ileko kortisolarekin duten erlazioa identifikatzea.

Planteatutako hipotesiak frogatu eta helburuak betetzeko asmoz, tesi honetan hiru azterlan burutu dira. Lehen lanaren helburua gizabanakoaren menpekoak ziren zenbait faktorek eta familia testuinguruak, eskola inguruak eta komunitateko faktoreek bullying rolekin zuten harremana aztertzea izan zen (5. irudia). Lan honetan ondorengo hipotesi eta helburuak landu ziren: Hi.1, H.O.1, H.O.2; H.E.1, H.E.2, H.E.3, H.E.4.

5 Irudia

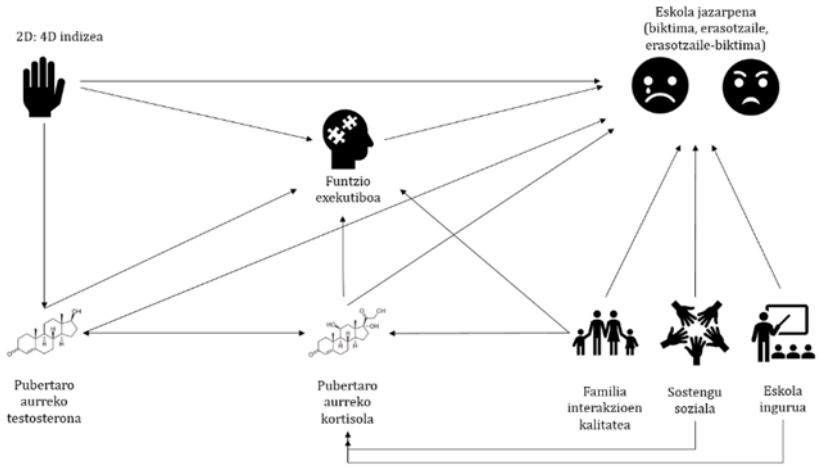
1. laneko eredua



Bigarren lanak, HPG eta HPA ardatzen menpekoak ziren hormonek faktore psikozozialekin batera bullyingean zuten eragina aztertzea bilatzen zuen. Zehazki, Hi.2, H.O.3; H.E.5, H.E.6 helburu eta hipotesiak landuz. Hortaz, jarraian azaltzen den eredua planteatu zen. Eredu honek hormonek eta faktore psikosozialek bullying jokabidean ikasleek hartu zitzaketen rolekin zuten harremana aztertzeaz ez ezik, aldagai hauek euren artean zituzten loturak ezartzea ere bilatzen zuen (ikus 6. irudia).

6 Irudia

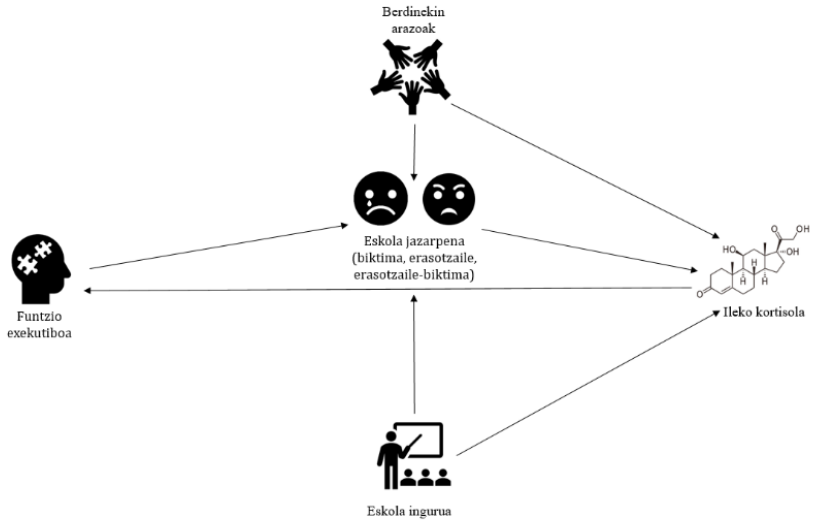
2. laneko eredua



Azkenik, 3. lanak eskola inguruaren menpeko aldagaiek eta bullyingak epe luzerako estresean eragiten zuen aztertu nahi izan zuen ileko kortisol mailak biomarkatzaile gisa erabiliz (7. irudia). Lan honetan Hi.3, H.O.4, H.E.7 eta H.E.8 helburu eta hipotesiak landu ziren.

7 Irudia

3. laneko eredua



4. Metodoa

4.1. Partaideak eta Diseinua

Tesi honetako parte-hartzaileak INMA (Haurtzaroa eta Ingurumena-Infancia y Medio Ambiente) proiektuko Gipuzkoa eta Sabadelleko familiak dira. Proiektu honen helburu nagusia ingurumen kutsatzaile desberdinek haurren garapenean eta osasunean duten eragina aztertzea da. INMA sarea 2003. urtean sortu zen eta ordutik, estatu mailan banatzen diren 7 kohorte edo azterketa-eremuetan (Asturias, Gipuzkoa, Granada, Menorka, Sabadell, Ribera d´Ebre eta Valentzia) bizi diren emakumeen eta hauen haurren jarraipena egin da (8. irudia).

8 Irudia

INMA proiektuko 7 ikerketa-eremuen lokalizazio geografikoa

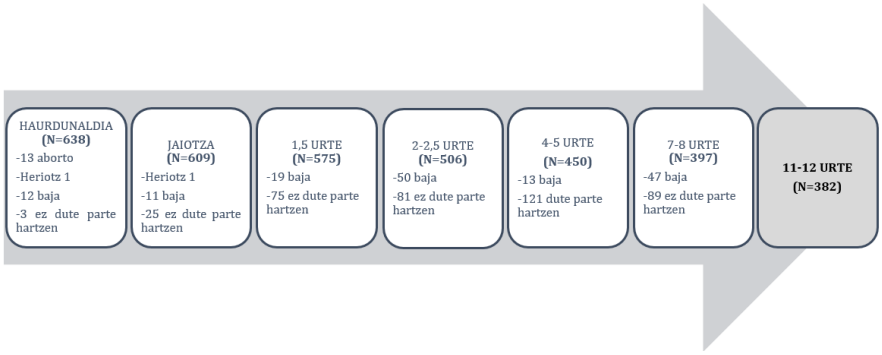
Oharra: www.proyectoinma.org web orritik eskuratua.

Gipuzkoako kohortea 2006. urteko maiatza eta 2008. urteko otsaila bitartean osatu zen. Sabadelleko kohortea, aldiz, 2004. urteko uztaila eta 2007. urteko uztaila bitartean. Gipuzkoan,

Zumarragako ospitalera, eta Sabadellen, CAP II Sant Felix zentrora lehen hiruhilekoko ekografia egitera joan ziren emakumeei proiektuan parte hartzeko aukera luzatu zitzaien. Parte hartu ahal izateko ondorengo inklusio irizpideak bete behar zituzten: 16 urte baina gehiago izatea, azterketa-eremuan bizitzea, haurdunaldiaren jarraipena eta erditzea erreferentziazko ospitalean egiteko asmoa izatea, komunikazio arazorik ez izatea hizkuntzari zegokionez (gaztelania, euskara edo katalana), haurdunaldi anizkoitza ez izatea, haurdunaldian zehar gaixotasun larririk ez izatea eta laguntza bidezko ugalketa jarraitu ez izana. Erreklutamendutik fase desberdinetan jarraipena egin zaie emakume hauei eta euren haurrei. Baina, 9 eta 10 irudiek erakusten duten moduan, jarraipen fase hauetan zehar arrazoi desberdinengatik laginaren galera progresibo bat eman da.

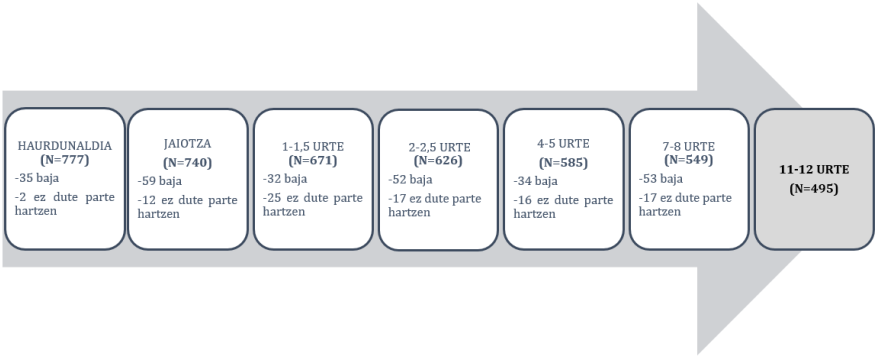
9 Irudia

INMA-Gipuzkoa kohorteko familia kopurua jarraipen fase desberdinetan



10 Irudia

INMA-Sabadell kohorteko familia kopurua jarraipen fase desberdinetan



Jarraipen fase guztietan jaso den informazioaren barruan, datu soziodemografikoak, ebaluazio neuropsikologikoa, aurrekari klinikoak, azterketa fisikoa edota lagin biologikoak (gernua, odola, ilea) aurkitzen dira. Gutxiengo informazio horretaz gain, kohorte bakoitzak informazio zehatz gehiago jasotzea erabaki dezake (Guxens et al., 2012).

Tesi honetan Gipuzkoako eta Sabadelleko haurren datuak erabili dira, bullyingaren buruzko informazioa soilik bi azterketa-eremu hauetan jaso zelako. Fase bakoitzean erreferentziazko etika batzordeak (Eusko Jaurlaritzako ikerketa klinikorako batzorde etikoak eta Parc de Salut Mar-eko ikerketa klinikorako batzorde etikoak) proiektuko fase bakoitza onartu zuen. Halaber, familia bakoitzak fase bakoitzean parte hartzeko adostasuna erakutsi zuen kontsentimendu informatuaren bitartez.

Proiektu hau, Carlos III.a Osasun Institutuari [FIS-PI06/0867, FIS-PI13/02187, CB06/02/0041, CP13/00054, CP16/00128,

CP18/0001, FIS-PI09/00090, FIS-PI18/011428, FIS-PI18/01237, PI041436, PI081151, PI12/01890, PI15/00118, PI16/00118, PI16/00261, PI17/01340, PI18/00547, PI20/18059, Red INMA G03/176]; Kataluniako Generalitateari [2014 SGR 822,2009 SGR 501]; Severo Ochoa Bikaintasuneko zentroari [CEX2018-000806-S]; Gipuzkoako Foru Aldundiari [DFG 89/17, DFG06/002, DFG08/001, DFG15/221]; Eusko Jaurlaritzako Osasun Sailari [2005111093, 2009111069, 2013111089, 2015111065, 2018111086]; Espainiako Ekonomiako Ministeritzari [SAF2012-32991]; Europa Batasuneko Komisioari [261357,308333,603794,634453] eta ikerketa eremuko udalerrien urteroko laguntzei (Zumarraga, Urretxu, Legazpi, Azkoitia, Azpeitia eta Beasain) esker finantzatu da.

4.2. Neurri Biologikoak

4.2.1. Jaio Aurreko Androgenoekiko eta Estrogenoekiko Esposizioa: 2D:4D Indizea.

2D:4D indizea, jaio aurreko testosterona eta estradiol mailei buruzko informazioa eskaintzen duen adierazle bat da. Eskuetako bigarren eta laugarren hatzetako luzera neurtzean eskuratzen da, bigarren hatzaren luzeraren balioa laugarren hatzaren luzeraren balioagatik zatitzean, hain zuzen (Lutchmaya et al., 2004; Trivers et al., 2006).

INMA proiektuan, 2D:4D indizea, 11 urteko jarraipen fasean neurtu zen aurrenerabeen ikastetxeetan. Behatzaile batek eskuen irudiak atera zituen eskaner eramangarri bat erabiliz (Epson

Perfection V39) eta Mikac eta lankideen (2016) lanean oinarritutako *ad hoc* protokolo bat jarraituz (11.1 eranskina). Jarraian, irudi horiek ordenagailu batera pasa ziren eta AutoMetrik programa erabiliz 2D:4D indizeak neurtu ziren (DeBruine, 2004). Doako programa honek bi parametro ditu, bigarren eta laugarren hatzetako luzerak neurtzeko erabiltzen direnak. Bi hatzen balioak erabiliz, programak automatikoki kalkulatzen du 2D:4D indizea. Bi eskuetako indizeak kalkulatu ostean, bi eskuen arteko korrelazioa kalkulatu zen eta honek funtsezko balioa erakutsi zuen (r=0.652; p=0.0001). Hori dela eta, Hönekopp et al.-en (2010) meta-analisian oinarrituz, soilik eskuineko eskuko datuak erabiltzea erabaki zen. Lan honek eskuineko eskuan 2D:4D indizean sexu desberdintasunak nabarmenagoak zirela erakutsi baitzuen.

Metodoaren fidagarritasuna frogatzeko Gipuzkoako haurren azpi-lagin batean (n=180) behatzaile arteko eta behatzaile barneko fidagarritasuna aztertu zen (11.2. eranskina). Emaitzek erakutsi zuten behatzaile barneko fidagarritasuna bikaina zela (ICC>0,98) eta behatzaile arteko fidagarritasuna, aldiz, onargarria (ICC>0,74).

4.2.2. Pubertaro Aurreko Hormona mailak: Testosterona eta Kortisola Listuan

Pubertaro aurreko testosterona eta kortisol mailak neurtzeko asmoz, 11 urteko jarraipen fasean, haur bakoitzari bi listu lagin jaso zitzaizkion. Aurrenerabeek eta hauen gurasoek lagin horiek etxean jaso zitzaten protokolo bat eta beharrezko materiala (11.3. eranskina) erraztu zitzaien. Aurrenerabeek edo hauen gurasoek laginak entregatu ondoren, aurretik entrenatutako ikertzaile batek,

listu laginak 2ml-ko kriobialetara pasa zituen. Jarraian, listu laginak 15 minutuz zentrifugatu ziren 3000 bira minutuko abiaduran listuko muzinak deuseztatzeko. Azkenik, laginak -80ºC tenperaturan gorde ziren analizatuak izan arte.

Listu laginak Euskal Herriko Unibertsitateko (UPV/EHU) Psikologia fakultateko laborategian analizatu ziren. Lagin guztiak bitan aztertu ziren entzima bidezko inmunoazterketa kitaren bitartez (Salimetrics, Satete College, PA, USA). Plakak 450nm Synergy™ HT plaka irakurlea erabiliz irakurri ziren (Bio-Tek Instruments, Inc., Winooski, VE, USA). Azterketen arteko batez besteko aldakuntza koefizientea %5 baina txikiagoa izan zen neurtutako bi hormonen kasuetan. Azterketa barneko batez besteko aldakuntza koefizientea, aldiz, %10-etik behera izan zen kortisolarentzat eta %12-tik behera testosteronarentzat. Aldakuntza koefizientea %10-etik gora zuten laginak berriz aztertu ziren. Bestetik, hormona maila detektatu zitekeen mugatik kanpo aurkitzen ziren laginak baztertuak izan ziren. Kitaren sentikortasuna <0.007 µg/dl-koa zen kortisolarentzat eta <1.0 pg/ml-koa testosteronarentzat. Analisi estatistikoak egin ahal izateko, hormona bakoitzaren kasuan, bi laginen datuekin batez bestekoa kalkulatu zen.

4.2.3. Kortisola Ilean Estres Kronikoaren Biomarkatzaile Gisa

Ile lagina eskolan jaso zen haurrek 11 urte zituztela. Lagin hauek aurretik entrenatutako pertsona batek jaso zituen *ad hoc* protokolo bat jarraituz (11.4. eranskina). Ile laginak Linköping Unibertsitateko Kimika Klinikoko laborategian aztertu ziren

erradioinmunoanalisi (RIA) konpetitiboa metanol erauzkinetan teknika bitartez.

Azken hiru hilabeteko kortisol mailak determinatzeko asmoz, ile laginetako lehen 3cm-ak aztertu ziren. Lehenik, ile laginak zati txikitan moztu ziren eta hauek 2ml-ko QiaGenRB tutuetara pasa ziren. Lagin hauek Sartorious MC 210p mikroeskalan pisatu eta Retch Tissue Lyzer II (20HZ) aparailua erabiliz homogeneizatu ziren. Ile laginak 3mg eta 10mg bitarte pisatu behar zuen inter azterketa koefiziente bariazioa %8 azpitik mantentzeko. Laginak moztu eta pisatu ostean, pulberizazio fasea ipini zen martxan. Ile laginak bi minutuz nitrogeno likidoan pulberizatu ziren, ile hautsa lortuz. Jarraian, lagin bakoitzari 100µl metanol gehitu zitzaion eta hau ile hautsarekin ondo nahasteko gau osoan zehar mugitzen utzi ziren. Hurrengo goizean, disoluzio horren 8 ml hartu eta Savant Speed Vac Plus SC210A makinaren bitartez lipolizatu ziren. Azkenik, laginak erradioinmunoazterketa soluzio indargetzailean disolbatu ziren. Erabilitako antigorputz nagusia untxi kortisol 3 poliklonal antigorputza izan zen, bigarren antigorputza anti-untxi IgG Sac Cell AA-Sac 1 (InmmunoDiagnostic System Ltd, Bordon, England) izan zen. Laginak 24-72 orduz inkubatu ziren, RIA bitartez aztertuak izan aurretik.

4.3. Ebaluazio Tresnak

4.3.1. Bullyinga: Olweus Bully Victim (OBVQ) Galdetegia (Olweus, 1996)

Bullyinga Olweus Bully Victim (OBVQ) galdetegiaren bertsio labur bat erabiliz ebaluatu zen. Galdetegi hau mundu mailan oso erabilia izan den eta ezaugarri psikometriko egokiak erakutsi dituen auto-betetze instrumentu bat da (Kyriakides et al., 2006).

Proiektuko partaideek 11 urteko jarraipen fasean euren eskoletan bete zuten galdetegia. Bullyinga ebaluatzeko erabilitako galdetegi hau definizio estandarizatu batez eta azken 2 hilabeteei erreferentzi egiten dien 16 galderaz osatua dago. Galdera hauek, bullying fisikoa, bullying psikologikoa, bullying soziala, cyberbullyinga eta bullying sexualari buruzko informazioa jasotzen dute. Lehen zortzi galderek biktima rolari egoerei buruzko informazioa jasotzen dute eta azken zortziek, erasotzaile rolari buruzko datuak. Galdera hauek 5 puntuko Likert eskalan erantzun behar ziren (0 “inoiz ez”, 1 “behin edo bitan bakarrik gertatu da”, 2 “hilean 2-3 aldiz gertatu da”, 3 “astean behin edo gertatu da”, 4 “astean behin baina gehiagotan gertatu da”).

Instrumentu honen datuak erabiliz aldagai desberdinak sortu ziren. Alde batetik, Solberg eta Olweusen (2003) aholkuei jarraiki lehen zortzi galderetako batean bi edo gehiago puntuatzen zuten haurrak biktima bezala identifikatuak izan ziren. Aitzitik, azken zortzi galderako batean bi edo gehiago puntuatzen zutenak erasotzaile kontsideratu ziren. Azkenik, hirugarren rol bat

identifikatu zen bi azpieskalatan bi baina gehiago puntuatu zuten haurrentzat: erasotzaile-biktima rola. Honi esker 2 kategoriako hiru aldagai sortu ziren: biktima (bai/ez), erasotzaile (bai/ez), erasotzaile-biktima (bai/ez).

Bestetik, behin aurrenerabeak hiru rol hauetan sailkatuak zeudela, hiru kategoriako aldagaiak sortu ziren bullyingean parte hartzen zuten maiztasunaren arabera. Aldagai hau Vaillancourt et al.-ek (2008) egindako lanean oinarrituta sortu zen. Horrela, bullyingaren maiztasunean oinarrituta hiru kategoriako hiru aldagai sortu ziren: biktima (biktima bezala parte hartzen ez zutenak, noizbehinkako biktima zirenak, maiz biktimizazioa jasaten zutenak), erasotzailea (erasotzaile bezala parte hartzen ez zutenak, noizbehinkako erasotzaileak zirenak, maiz erasotzaile bezala parte hartzen zutenak), erasotzaile-biktima (erasotzaile-biktimak ez zirenak, noizbehinkako erasotzaile-biktimak zirenak, maiz erasotzaile-biktima bezala parte hartzen zutenak).

INMA proiektuko datuetan eskalak kontsistentzia egokia erakutsi zuen. Zehazki, α=0,81 galdetegi osoarentzat, α=0,81 biktima eskalarentzat eta α=0,67 erasotzaile eskalarentzat.

4.3.2. Portaera Arazoak: Gaitasun eta Zailtasunei Buruzko Galdetegia (SDQ) (Goodman, 1997)

Aurrenerabeen gurasoek galdetegi honi erantzun zioten 8 eta 11 urteko jarraipen fasetan. Galdetegi hau 5 azpieskalatan banatzen diren 25 galderek osatzen dute: sintoma emozionalak, portaera arazoak, hiperaktibitate-arreta eza, berdinekin arazoak

eta portaera prosoziala. Item bakoitza hiru puntuko Likert eskalan erantzun behar dira, aurrenerabeen azken 6 hilabetetako jokabidearen arabera (0 “ez da egia”, 1 “egi samarra”, 2 “egia benetan”).

Ikerketa honetarako, puntuazio totalen eskala eta berdinekin arazoak azpieskala erabili ziren, puntuazio altuagoak jokabide arazo gehiagoren erakusle izanik. Galdetegiak ezaugarri psikometriko egokiak erakutsi ditu Espainiako laginean (Rodríguez-Hernández et al., 2012) eta zehazki, lagin honetan, barne kontsistentzia altua dela ikusi zen (α=0,78).

4.3.3. Bizi Kalitatea: Kidscreen-27 Galdetegia (Kidscreen-27)

Kidscreen-27 galdetegia erabiliz, 11 urteko jarraipen fasean, aurrenerabeek azken astean zuten ongizateari buruzko informazioa jaso zen. Galdetegi hau bost puntuko Likert eskalan (1 “ezer ez/inoiz ez”, 2 “pixka bat/ia behin ere ez”, 3 “neurrian/batzuetan”, 4 “asko/ia beti”, 5 “ikaragarri/beti”) erantzun behar diren 27 itemez osatua dago. Hauek guztiak, 5 azpieskalatan banatzen dira: ongizate fisikoa, ongizate psikologikoa, berdinak eta sostengu soziala, gurasoak eta autonomia, eta eskola ingurua. Kasu guztietan, puntuazio altuagoak neurtutako konstruktuan kalitate edo ongizate handiagoaren erakusle dira.

Galdetegi hau Espainiako laginetan balidatua izan da eta ezaugarri psikometriko egokiak dituela erakutsi du (Molina et al., 2014; Quintero et al., 2011). Halaber, tesian erabilitako laginean

galdetegiak barne kontsistentzia egokia erakutsi zuen azpieskala guztietan: ongizate fisikoa (α=0,71), ongizate psikologikoa (α=0,72), gurasoak eta autonomia (α=0,73), berdinak eta sostengu soziala (α=0,73) eta eskola ingurua (α=0,70).

4.3.4. Arreta Defizita eta Hiperaktibitatearen Nahasmenduaren (ADHN) Sintomatologia: Conners Eskala Berrikusia (CPRS-R) (Conners, 1997)

Proiektuko 8 eta 11 urteko jarraipen faseetan gurasoek eskala honi erantzun zioten. Eskala honek haurren jokabide arazoak ebaluatzen ditu azken hilabeteari erreparatuz. Lau puntuko Likert eskalan (0 “ez da egia” 3 “guztiz egia”) erantzun behar diren 27 itemez osatua dago, hiru azpieskalatan banatzen direnak: oposiozko jokabideak, arazo kognitiboak/arreta eza eta hiperaktibitatea. Ikerketa honetarako arreta defizitaren eta hiperaktibitatearen nahasmenduaren sintomatologiaren erakusle gisa ADHN neurri orokorra erabiltzea erabaki zen.

Conners eskalak oso erabiliak izan dira mundu mailan eta gaztelaniako bertsioan ezaugarri psikometriko egokiak erakutsi dituzte (Hidalgo-Rasmussen et al., 2015). INMA laginean ere kontsistentzia egokia erakutsi zuen ADHN indizeak (α=0.92).

4.3.5. Atentzioa: ANT (Attention Network Task) Testa (Rueda et al., 2004)

Partaideek 8 eta 11 urteko jarraipen fasean ordenagailuko test hau egin zuten. ANT testak atentzioa ebaluatzen du eta 5 geziz osaturiko ilera bateko erdiko geziak seinalatzen duen norabidea

identifikatzean oinarritzen da. Partaideei ordenagailuko teklatuko gezien botoiak erabiliz, ahalik eta bizkorren geziaren norabidea zehazteko eskatzen zitzaien. Test hau 4 bloketan banatzen ziren 128 probek osatzen dute. Ikerketa honetan kolpearen erreakzio denboraren errore estandarra erabili zen, arreta gabeziaren erakusle dela kontsideratzen dena.

4.3.6. Erabaki Arriskutsuak Hartzea: Cups Task Roulette Version (Levin et al., 2007)

Aurrenerabeen erabaki arriskutsuak hartzea ebaluatzeko ordenagailuko test hau erabili zen 11 urteko jarraipen fasean. Test honetan haurrari edo nerabeari zati desberdinetan banatzen diren bi gurpil erakusten zaizkio. Gurpiletako batek segmentu guztietan diru kopuru bera du, besteak, aldiz, diru kopuru desberdina. Haur edo nerabeek gurpil bat edo bestea aukeratu behar dute eta aukeratutako gurpila bi segundoz biraka egon ostean irabazi edo galdutako diru kopurua erakutsiko du ordenagailuak. Ikerketa honetan arriskuko erabaki totalen neurria erabili zen, arriskuko erabaki gehiago hartzea funtzio exekutibo okerrago baten erakusle kontsideratuz.

4.3.7. Familia Testuingurua: Haezi-Etxadi Eskala (Barreto et al., 2018)

Familiaren testuingurua ebaluatzeko, aurrenerabeen gurasoek 8 urteko jarraipen fasean galdetegi honi erantzun zioten. Galdetegi hau 5 azpieskalatan banatzen ziren 85 itemez osatua zegoen: garapen kognitibo eta linguistikoaren promozioa, garapen

sozioemozionalaren promozioa, inguru fisikoaren eta testuinguru sozialaren antolakuntza, gurasoen estres eta gatazka, eta gurasoek haurren garapenaren sustapenean duten profila. Azpieskala hauetan puntuazio altuago bat izatea familia testuinguruaren kalitate altuagoarekin erlazionatzen da.

Eskala honen ezaugarri psikometrikoak egokiak dira eta INMA laginean barne kontsistentzia egokia erakutsi zuten: α=0,79, α=0,83, α=0,73 α=0,75 eta α=0,80 hurrenez hurren. Tesi honetan gurasoen estres eta gatazka azpieskala erabili zen gaiarekin duen loturagatik.

4.3.8. Kohesio Soziala eta Bizilagunekiko Fidagarritasuna: ad hoc galdetegia (Sampson et al., 1997)

Gurasoek, Sampson et al.-en (1997) galdetegian oinarritzen zen *ad hoc* galdetegi bat bete zuten 11 urteko jarraipen fasean. Galdetegi hau lau galderaz osatzen zen, 5 puntuko Likert eskalan (0 "erabat/guztiz ados"-4 "guztiz ez ados") erantzun behar zirenak. Galdera hauetan puntuazio altuak lortzea bizilagunenganako kohesio eta fidagarritasun baxuagoaren erakusle ziren. Gure laginean galdera hauek barne kontsistentzia egokia erakutsi zuten (α=0,79).

4.3.9. Galdetegi Soziodemografikoa: ad hoc Galdetegia

Galdetegi honek gurasoen aldagai soziodemografikoak, familia ezaugarriak (anai arreba kopurua, berdinekin bizitzea), gurasoen adina, hezkuntza maila eta klase soziala ebaluatzen zituen. Honetaz gain, familiarekin erlazionatutako haurrak bizitzen zituen gertaera

estresagarriei buruzko informazioa ere jaso zen: etxebizitza aldaketa, eskola aldaketa, gurasoen banatzea, familiako baten ospitalizazio luzea edo heriotza. Bestetik, eskolako zuzendariei eskola motaren eta ikasle kopuruari buruz galdetu zitzaien.

4.3.10. Kalifikazioak: ad hoc Galdetegia

Ad hoc galdetegi bat erabiliz aurrenerabeen kalifikazioei buruzko informazioa jaso zen irakasleei 5 galderez osaturiko galdetegi bat administratuz. Galdera hauek 6 puntuko Likert eskala erabiliz (1 "bere ikaskideek baina askoz ere gutxiago", 2 "bere ikaskideak baina gutxiago", 3 "bataz bestekoan baina apur bat gutxiago", 4 "bataz bestekoan baina apur bat gehiago", 5 "bataz bestekoa baina gehiago", 6" bataz bestekoa baina askoz ere gehiago") erantzun behar ziren. Irakasleak partaide bakoitzak zituen gaitasunak ebaluatu behar zituen irakurmenari, atentzioari, matematikari, gaztelania eta euskarari dagokionez. Ikerketa lan honetan puntuazio total bat kalkulatu zen area desberdinetan aurrenerabeek zituzten gaitasunen batez bestekoarekin.

4 Taula

Erabilitako tresnen laburpena

Tresna	Jarraipen fasea	Nork	Tresna mota	Ebaluatutako aldagaia	Item kopurua	Denbora-tartea
OBVQ galdetegia	11	A	Ga	Bullyinga	16	Azken 2 hilabeteak
Kidscreen-27 galdetegia	11	A	Ga	Ongizate fisikoa, ongizate psikologikoa, berdinak eta sostengu soziala, guraso eta autonomia eta, eskola ingurua	27	Azken astea
Gaitasun eta Zailtasunen galdetegia (SDQ)	8 eta 11	G	Ga	Portaera arazoak	25	Azken 6 hilabeteak
Conners eskala (CPRS-R)	8 eta 11	G	Ga	ADHN sintomatología	27	Azken hilabetea
ANT (Attention Network Task) testa	8 eta 11	A	O	Atentzioa	-	-
Cups Task, Roulette Version	11	A	O	Funtzio exekutiboa	-	-
Familia testuingurua ebaluatzeko Haezi-Etxadi eskala (HEFAS 7-11)	8	G	Ga	Guraso testuingurua	85	-
Komunitateko faktoreak	11	G	Ga	Kohesio soziala eta fidagarritasuna	4	Une horretan
Kalifikazioak	11	I	Ga	Aurrenerabeen Errendimendu akademikoa	5	Une horretan

Oharra: A=aurrenerabeek; G=gurasoek; I= irakasleak; Ga=galdetegia; O=ordenagailuko testa.

4.4. Datuen Analisia

Tesi hau osatzen duten artikuluen datuen analisia planteatutako helburuen eta aldagai motaren araberakoa da. Lehen artikuluaren helburua eskola jazarpenean aurrenerabeek hartu ditzaketen hiru rolen aurrean (biktima, erasotzailea, erasotzaile-biktima) arrisku nahiz babes faktore gisa eragin dezaketen aurrekariak identifikatzea izan zen. Zehazki, gizabanakoarekin, familiarekin, eskola inguruarekin eta komunitatearekin

erlazionatutako faktoreak aztertzea bilatzen zuen. Horretarako, hiru erregresio logistiko (rol bakoitzeko bat) egin ziren.

Bigarren lanak, hiru helburu zituen: jaio aurreko eta pubertaro aurreko garaiko hormona mailek bullyingarekin zuten erlazioa aztertzea, aurrenerabeen testuinguru psikosozialak bullyingarekin zuen lotura ikertzea eta hormona mailek aldagai psikosozialean zuten eragina aztertzea. Hau guztia konprobatzeko asmoz, sei egitura-ekuaziozko eredu (SEM: Structural Equation Modeling) egin ziren (bullying rolak eta sexua aintzat hartuz).

Azken artikuluan eskola inguruak eta bullyingak estres kronikoan duten eragina aztertu nahi zen, ileko kortisola biomarkatzaile gisa hartuz. Horretaz gain, aldagai askeek euren artean duten lotura aztertu nahi izan zen. Helburu horrekin hiru SEM eredu burutu ziren (rol bakoitzarekin bat).

5. taulan, tesia osatzen duten hiru lanetan egindako analisi estatistikoak laburtzen dira, zeinak, ondorengo atalak biltzen dituen: ikerketaren helburua, ikerketa mota, menpeko aldagaia, aldagai askeak eta erabilitako datu analisiak.

5 Taula

Erabilitako datu analisien laburpena

Ikerketaren helburua	Kohorteak	Menpeko aldagaia	Aldagai askeak	Erabilitako analisi estatistikoak
1. Artikulua: Risk and protective factors for bullying at 11 years of age in a Spanish birth cohort study.				
Aurrenerabeek eskola jazarpenean hartu ditzaketen hiru rolen aurrean (biktima, erasotzaile, erasotzaile-biktima) gizabanakoarekin, familiarekin, eskola eta komunitatearekin erlazionatutako arrisku nahiz babesle diren aurrekariak identifikatzea.	Gipuzkoa eta Sabadell	**Bullying rolak:** -Biktima (0=inplikazio eza, 1=biktima izatea). -Erasotzailea (0=inplikazio eza, 1=erasotzaile izatea) -Erasotzaile-Biktima (0=inplikazio eza, 1=erasotzaile-biktima izatea).	**Gizabanakoaren aurrekariak:** -Sexua -Portaera arazoak (SDQ) -ADHN sintomatologia (Conners eskala) -Atentzioa (ANT) -Funtzio exekutiboa (Cups Task) -Ongizate fisiko eta psikologikoa (Kidscreen-27) -Bizitza gertaera estresagarriak (*ad hoc)* **Familia aurrekariak:** -Familia testuingurua (Haezi-Etxadi eskala) -Gurasoekin harremana eta autonomia (Kidscreen-27) **Eskola, komunitate aurrekariak eta aurrekari sozialak:** -Berdinekin harremana eta sostengu soziala (Kidscreen-27) -Eskola ingurua (Kidscreen-27) -Kohesio soziala eta fidagarritasuna (*ad hoc)*	**Deskriptiboak:** -Aldagaien deskripzioa: Bataz bestekoa eta desbiderapen tipikoa, frekuentzia eta portzentaiak. -Prebalentzia: Frekuentziak eta portzentaiak. **Bibarianteak (menpeko aldagaia eta aldagai askeen arteko erlazioak):** -T-test eta Chi-kararatua. **Analisi estatistikoa:** -Erregresio logistiko bitarra.

2. Artikulua: Do prenatal and prepubertal hormones and the psychosocial context jointly explain 11-year-old preadolescents' involvement in bullying?				
1. Jaio aurreko eta pubertaro aurreko hormona mailek bullying jokabidearekin duten harremana aztertzea. 2. Aurrenerabeen aldagai psikosozialek eskola jazarpenarekin duten harremana aztertzea. 3. Hormona mailek aldagai psikosozialekin duten lotura ezartzea.	Gipuzkoa	**Bullying rolen maiztasuna:** -Biktima (0=inplikazio eza, 1=noizbehinka, 2=maiz). -Erasotzailea (0=inplikazio eza, 1=noizbehinka, 2=maiz). -Erasotzaile-biktima (0=inplikazio eza, 1=noizbehinka, 2=maiz).	**Hormona mailak:** -2D:4D indizea -Testosterona listuan -Kortisola listuan **Aldagai psikosozialak:** -Funtzio exekutiboa (SDQ) -Familia testuingurua (Haezi-Etxadi eskala) -Berdinekin harremana eta sostengu soziala (Kidscreen-27) -Eskola ingurua (Kidscreen-27) **Beste aldagaiak:** -Sexua	**Deskriptiboak:** -Aldagaien deskripzioa: Bataz bestekoa eta desbiderapen tipikoa, frekuentzia eta portzentaiak. -Prebalentzia: Frekuentziak eta portzentaiak. **Bibarianteak (menpeko aldagaia eta aldagai askeen arteko erlazioak):** -ANOVA eta Chi-kararatua. **Analisi estatistikoa:** -SEM analisiak.
3. Artikulua: Hair cortisol as a biomarker of chronic stress in preadolescents: influence of school context and bullying.				
Eskola inguruak orokorrean eta zehazki bullyingak estres kronikoarekin duen erlazioa aztertzea, ileko kortisola erabiliz.	Gipuzkoa eta Sabadell	-Ileko kortisola	**Bullying rolak:** -Biktima (0=inplikazio eza, 1=biktima izatea). -Erasotzailea (0=inplikazio eza, 1=erasotzaile izatea) -Erasotzaile-Biktima (0=inplikazio eza, 1=erasotzaile-biktima izatea). **Eskola ingurua:** -Eskola ingurua (Kidscreen-27) -Berdinekin arazoak (SDQ) **Beste aldagaiak:** -Funtzio exekutiboa (Cups Task)	**Deskriptiboak:** -Aldagaien deskripzioa: Media eta desbiderapen tipikoa, frekuentzia eta portzentaiak. -Prebalentzia: Frekuentziak eta portzentaiak. **Bibarianteak (menpeko aldagaia eta aldagai askeen arteko erlazioak):** -ANOVA eta Chi-kararatua. **Analisi estatistikoa:** -SEM analisiak.

5. Emaitzen Laburpena eta Eztabaida

5.1. Emaitzen Laburpena

Atal honek tesian jorratu diren hiru lanen emaitza esanguratsuenak biltzen ditu, aurretik definitutako hipotesi eta helburuak oinarritzat hartuz.

Lehenengo ikerketa lanak, *"Risk and Protective Factors for Bullying at 11 Years of Age in a Spanish Birth Cohort Study"* artikuluak, gizabanakoarekin, familiarekin, eskolarekin nahiz komunitatearekin erlazioa zuten eta bullying jokabidearen arrisku nahiz babes faktore izan zitezkeen aldagaiak identifikatzea zuen helburu nagusitzat. Horretarako, hiru erregresio eredu egin ziren, aurrenerabeek bullying egoeratan hartu zitzaketen rol bakoitzarekin (biktima, erasotzailea, erasotzaile-biktima) bat. Lan honen beste helburuetako bat INMA Gipuzkoa eta Sabadell kohortetako partaideen datuak erabiliz bullying prebalentzia kalkulatzea zen.

Lan honetako datuek, aurrenerabeen %12,3ak bullying egoeratan parte hartzen zuela erakutsi zuten, aurrenerabeen %9,3a biktima, %1,4a erasotzaile eta %1,6 erasotzaile-biktima izanik. Bullyingaren arrisku eta babes faktoreei dagokionez, ADHN sintomatologiak (OR=1,49; %95 KT=1,22-1,82) biktima izateko arriskua handitzen zuela aurkitu zen. Aldiz, gurasoekin harreman hobea izatea (OR=0,32; %95 KT=0,16-0,66) eta sostengu sozial egoki bat izatea (OR=0,99; %95 KT= 0,98-0,99) biktima izateko babes faktore zirela ikusi zen. Erasotzaileen ereduari dagokionez,

lagin osoko datuak erabiltzean, hau estatistikoki esanguratsua ez zela ikusi zen (*p*=0,07). Soilik Gipuzkoako datuak erabiltzean, ordea, familiako kide bat ospitalizatua izatea erasotzaile rolarekin erlazionatzen zela (OR=7,32; %95 KT=1,15-46,56) erakutsi zuten lan honetako datuek. Azkenik, erasotzaile-biktima rolari erreparatuz, 8 urterekin portaera arazoak izatea (OR=2,58; %95 KT=1,21-5,52) 11 urterekin erasotzaile-biktima rola hartzeko arrisku faktore bat zela aurkitu zen. Eskola inguru egoki bat izatea, ostera, rol hau hartzeko arriskua gutxitzen zuela (OR=0,68; %95 KT=0,45-1,01) ikusi zen. Beraz, lan honetako emaitzek erakutsi zuten lan honetan planteatutako hipotesia betetzen zela; izan ere, gizabanakoaren eta, familiaren, eskolaren eta komunitatearen menpeko zenbait aldagaik aurrenerabeen bullying rolen aurrean arrisku nahiz babes faktore gisa jokatzen zutela ikusi zen.

Tesian landutako bigarren ikerketa lanean, *"Do Prepubertal Hormones, 2D:4D Index and Psychosocial Context Jointly Explain 11-year-old Preadolescents' Involvement in Bullying?"* artikuluan, aldagai psikosozialekin batera, hormona mailek bullyingean zuten eragina aztertu nahi izan zen. Horretarako, bullying rola eta aurrenerabeen sexua kontuan izanik sei SEM eredu eraiki ziren. Neska biktimen kasuan, familiarekin kalitatezko harremanak izatea biktima izateko arriskua gutxitzen zuen (*b*=-0,22; *p*=0,042). Mutiletan, ordea, eskola ingurua positiboago hautemate zuten aurrenerabeek biktima izateko arrisku gutxiago zutela ikusi zen (*b*=-0,25; *p*=0,035). Erasotzaileen rolari erreparatuz, nesken ereduan, biktimen kasuan gertatzen zen moduan, familiarekin harreman hobeak izatea erasotzaile izateko arriskua gutxitzen

zuen (*b*=0,22; *p*=0,040). Bestetik, mutil erasotzaileen kasuan lan honetako hipotesia partzialki frogatu zen, izan ere, eredu honetan, kortisol maila baxuak (*b*=-0,23; *p*=0,051), eskola inguru okerrago (*b*=-0,22; *p*=0,120) eta berdinekin harreman eta sostengu sozial okerragoa (*b*=0,30; *p*=0,048) izatearekin batera, erasotzaile izatearekin erlazionatzen zela ikusi zen, bariantzaren %25,5a azalduz. Erasotzaile-biktima rola aintzat hartuz ereduak eraikitzean, ez zen eredu esanguratsurik lortu.

Aldagai askeen arteko harremanei dagokionez, mutiletan, sostengu sozial handiago bat izatea, kortisol maila altuagoekin (*b*=0,53; *p*=0,001) erlazionatzen zela ikusi zen, bai biktima rola eta baita erasotzaile rola kontutan hartzerakoan ere. Bestetik, testosterona maila altuagoa zuten neskek eskola inguru okerrago bat hautematen zutela erakutsi zuten (*b*=-0,20; *p*=0,007). Azkenik, eredu guztietan pubertaro aurreko testosterona eta kortisol mailen artean korrelazio positibo bat aurkitu zen (*p*<0,001). Hortaz, planteatutako hipotesia partzialki konfirmatu zela esan daiteke, hiru roletatik batean eta soilik mutiletan ikusi baitzen hormonek testuinguru psikosozialarekin batera bullyingean zeresana zutela.

Hirugarren lanean, *"Hair Cortisol as a Biomarker of Chronic Stress in Preadolescents: Influence of School Context and Bullying"* izenburupean, eskola inguruarekin zerikusia zuten zenbait aldagaik (berdinekin harremanak, eskola inguruaren hautematea, kalifikazioak eta bullyinga) aurrenerabeen estres mailetan zuten eragina aztertu zen. Helburu hori frogatzeko, hiru SEM eredu eraman ziren aurrera, aurrenerabeek bullyingean hartzen zuten rol

bakoitzarekin bat. Lan honen emaitzek erakutsi zuten ikertutako eskola aldagaietatik (eskola ingurua, berdinekin arazoak, bullyinga eta kalifikazioak) soilik bullyinga erlazionatzen zela modu zuzenean eta marjinalki ileko kortisol mailekin. Zehazki, erasotzaile biktima izatea ileko kortisol maila altuagoekin lotuta zegoela aurkitu zen (b=0,075; p=0,056).

Bestalde, aldagai askeen arteko loturari dagokionez, berdinekin arazoak izatea biktima izateko arriskua areagotzen zuela ikusi zen (b=0,130; p=0,001). Eskola ingurua egokitzat hautematea, ordea, biktima izateko garaian babes faktore bat zela aurkitu zen (b=-0,132; p=0,001). Hiru ereduetan aurkitutako beste emaitza interesgarri bat, ileko kortisolaren eta funtzio exekutiboaren arteko harremana izan zen. Zehazki, ileko kortisol maila altuek aurrenerabeek hartzen zituzten arriskuko erabaki gehiagorekin (funtzio exekutibo okerragoen erakusle) erlazionatzen zela ikusi zen (p<0,01).

Azkenik, eskolako kalifikazioek ileko kortisolarekin eta eskolako aldagai desberdinekin zuten lotura ere ikertu zen lan honetan, baina soilik Gipuzkoako partaideen datuak erabiliz. Eredu honetan, ikasleen kalifikoazioak ileko kortisol mailekin erlazionatzen ez zirela ikusi zen. Aldagaien arteko loturari erreparatuz, biktima ziren aurrenerabeak (b=-0,148; p=0,006) edota berdinekin arazo gehiago zituzten ikasleek (b=-0,121; p=0,024) eskola kalifikazio okerragoak zituztela aurkitu zen. Ildo beretik, funtzio exekutibo okerragoak zituzten aurrenerabeek ere

kalifikazio okerragoak zituztela erakutsi zuten azken azterlan honetako emaitzek (*b*=-0,093; *p*=0,082).

Beraz, hirugarren azterlanean topatutako emaitzei erreparatuz, hasieran planteatutako hipotesia partzialki betetzen zela esan daiteke. Izan ere, eskola inguruko aldagaietatik bakarra erlazionatzen da, eta modu marjinalean, ileko kortisol mailekin.

5.2. Emaitzen Eztabaida

Atal honetan tesia osatzen duten hiru ikerketa lanetan lortutako emaitzen eztabaida lantzen da.

Lehenik eta behin, eskola jazarpenaren prebalentziari dagokionez, aurrenerabeen %12,3ak bullyingean parte hartzen zuela aurkitu zen, ikerketa honetako datuek, partaideen %9,3 biktima, %1,4 erasotzaile eta %1,6 erasotzaile-biktima gisa parte hartzen zutela erakutsiz. Antzeko adina zuten partaideekin egindako ikerketek emaitza berdintsuak erakutsi dituzte. MOE-k duela urte batzuk egindako ikerketa batean, 11 urte zituzten aurrenerabeen %13 eta %8 inguru, hurrenez hurren, bullying biktima eta erasotzaile zirela aurkitu zuen (Currie et al., 2012). Espainia mailan, ordea, berrikuspen sistematiko batek ikasleen %11,4a bullyingean parte hartzen zuela ondorioztatu zuen (García-García et al., 2017).

Hormona mailei dagokionez, tesiko aurrenerabeek beste ikerketa batzuetan erabilitako laginekin alderatuz, antzeko datuak zituztela ikusi zen. 2D:4D indizeari erreparatuz, ikerketa honetako partaideen eskuineko indizeak batez beste 0,956 (DT:0,038)

neurtzen zuen mutiletan eta neskena 0,970 (DT:0,036) inguru zegoen. Aurreko ebidentzian ikusi zen modura, 2D:4D indizea 1 balorearen inguru aurkitzen zen eta mutilek neskek baina balore baxuagoak zituzten (Hönekopp & Watson., 2010). Pubertaroko hormona mailei dagokionez, adin bereko partaideekin egindako ikerketa batek, testosterona maila berdintsuak zituztela erakutsi zuen (Nguyen et al., 2018). Lan berean aurrenerabeei neurturiko listuko kortisol mailak, aldiz, tesi honetako partaideen datuak baina baxuagoak ziren. INMA Gipuzkoako partaideen listuko kortisol mailak, aurretik 8 urteko haurrekin egindako ikerketa bateko partaideen datu antzekoak zirela ikusi zen (Pascual-Sagastizabal et al., 2019). Ileko kortisol mailei dagokionez, haurtzaro eta nerabezaro garaian gutxitan ikertuak izan dira. Noppe et al.-ek (2014) ileko kortisol kontzentrazioak adinarekin handitzen zirela ondorioztatu zuten. Eta tesi honen hirugarren azterlaneko ileko kortisol mailak aurreko ebidentzian antzeko adineko partaideen ileko kortisol datuekin alderatuz, balore berdintsuak zituztela ikusi zen (Vanaelst et al., 2012; Noppe et al., 2014; Gerber et al., 2017).

5.2.1. Aldagai Psikosozialen eta Bullyingaren Arteko Erlazioari Buruzko Emaitzen Eztabaida

Lehen lanak, *"Risk and Protective Factors for Bullying at 11 Years of Age in a Spanish Birth Cohort Study"* izenburupean, aldagai psikosozialek bullyingarekin zuten lotura aztertzea zuen helburu. Gizabanakoaren faktoreen artean, portaera arazoak izatea bullyingean parte hartzeko arriskua areagotzen zuela ikusi zen. Zehazki, 8 urtetan portaera arazo gehiago zituzten haurrek 11

urterekin erasotzaile-biktima izateko arrisku gehiago erakutsi zuten. Halaber, ADHN sintomatologia biktima izatearekin erlazionatu zen, biktimak ziren aurrenerabeek sintomatologia gehiago izanik. Lehen azterlanean topatutako emaitzak aurreko ebidentziarekin bat datoz, non, portaera arazoak izatea (Boel-Studt & Renner, 2013) eta, batez ere, ADHN sintomatologia (Holmberg & Hjern, 2008; Verlinden et al., 2015) edota hiperaktibitatea (Rolim de Moura et al., 2011) izatea bullying inplikazioarekin erlazionatu den. ADHN sintomatologia duten haur eta nerabeek bullying jokabidean parte hartzeko duten arriskua arrazoi desberdinengatik azaldu daiteke. Alde batetik, biktima izateko arriskua ADHN sintomatologia duten pertsonek izan ohi duten erreaktibotasun emozionalarekin edota gaitasun sozialen defizitarekin lotuta egon daiteke. Bestetik, erasotzaile rolari dagokionez, ADHN sintomatologia duten haur eta nerabeek inpultsibotasun altuagoa izan ohi dutenez, agresibitate jokabideak izateko arrisku gehiago izan dezaketela uste da, bullying portaerarekin lotura zuzena izan dezakeena (Murray et al., 2020).

Dena dela, ikerketa honek ez zuen eskola jazarpenaren aurresale moduan gehien aztertuak izan diren gizabanakoaren menpekoak diren bi faktoreren efektua ikusi. Alegia, sexua eta adinak ez zuten estatistikoki esanguratsua zen loturarik aurkitu bullying inplikazioarekin. Sexuari dagokionez, neskekin alderatuz, mutilek, biktima (Han et al., 2017; Hemphill et al., 2012), erasotzaile (Atik & Güneri, 2013; Connell et al., 2016; Han et al., 2017; Jansen et al., 2011) nahiz erasotzaile-biktima (Jansen et al., 2011) moduan gehiago parte hartzen dutela erakutsi dute aurreko

ikerketek. Tesia osatzen duten beste bi azterlanetan ere sexuaren efektua ikertu zen eta aldagai honek bullyingean efektu zuzena ez zuela erakutsi zuen. Sexua eta bullyingaren artean harreman estatistikorik ez ikustea, neurri batean, bullyinga neurtzeko erabili zen galdetegiarengatik izan daiteke. Aurreko lan batzuetan ikusi zen sexuaren arabera bullying inplikazioan ematen diren desberdintasunak bullying motarengatik azalduak izan zitezkeela, nesketan bullying ez zuzenaren prebalentzia handiagoa zela ondorioztatuz (Boel-Studt & Renner., 2013). Ikerketa honetan erabilitako OBVQ galdetegiak bullying mota desberdinak (hitzezko bullyinga, bullying fisikoa, baztertze bullyinga, cyberbullyinga eta bullying sexuala) ebaluatzen ditu bere baitan. Baina, laginaren tamainak ezartzen zuen mugagatik, bullying motaren araberako analisiak ez egitea erabaki zen.

Bestetik, aurreko ebidentziak adina ere eskola jazarpenaren jokabidearekin erlazionatzen dela erakutsi du. Salbuespenak salbu, bullying fenomenoaren prebalentzia handiena ikasleek 11-13 urte inguru dituztela ematen da eta adin honetatik aurrera prebalentzia gutxituz doala ikusi da (Eslea & Rees, 2001). Beste ikerketa batzuk adin hau apur bat beranduago ezarri dute, 12-14 urte inguruan, hain zuzen (González-Cabrera et al., 2019). Tesiko lehen azterlanean adinaren efektua ikusi ez izana arrazoi desberdinen ondorio izan daiteke. Azalpen nagusiena ikerketa diseinuari lotuta egongo litzateke. Ikerketa honetako partaideak adin tarte berekoak dira, honen arrazoia, INMA proiektuko ikerketa diseinua izanik. Hori dela eta, adinaren aldakortasuna txikia denez, ez da harritzekoa aldagai honek efektua ez ikusi izana. Gainera, ikerketa

honetako partaideak batez beste 11 urte inguru zituzten aurrenerabeak ziren, ikerketaren momentuan lehen hezkuntzako azken urteetan aurkitzen zirenak. Hori ere aintzat hartu beharko litzateke prebalentziaz hitz egiterakoan. Eskola jazarpena nerabezaroko garai desberdinetan aztertu dutenek, kasu larrienak nerabezaro goiztiarrean (11-13 urte inguru) ematen direla ikusi dute, batez ere, haurrak lehen hezkuntzatik bigarren hezkuntzara aldatzen direnean. Ikerketa honetako partaideak gazteagoak izateak aurkitutako prebalentzian eta adinak eskola jazarpenarekin duen harremanean eragin dezake (García-Cabrera et al., 2022).

Horretaz gain, tesi hau osatzen duten hiru ikerketa lanek funtzio exekutiboek bullyingarekin zuten lotura aztertu zuten. Aurreko ebidentziak harreman hau frogatu duen arren (Kloosterman et al., 2014), tesiko emaitzek ez zuten erlazio hau baieztatu. Honen arrazoi bat, INMA proiektuko partaideak Kloosterman et al.-en partaideak baina gazteagoak zirela izan daiteke. Hori dela medio, oraindik funtzio exekutiboaren garapena ematen ari dela pentsa daiteke. Beste arrazoi bat, funtzio exekutiboa ebaluatzeko tresna izan daiteke. Tesian funtzio exekutiboak ordenagileko test neuropsikologiko baten bitartez ebaluatu ziren, aldiz, Kloosterman et al.-ek (2014) gurasoek erantzundako galdetegi baten bitartez ebaluatu zuten aldagai hau.

Familia aldagaiek bullyingean zuten eragina tesia osatzen duten bi azterlanetan aztertu zen (*"Risk and Protective Factors for Bullying at 11 Years of Age in a Spanish Birth Cohort Study"* eta *"Do Prepubertal Hormones, 2D:4D Index and Psychosocial Context Jointly*

Explain 11-year-old Preadolescents' Involvement in Bullying?" artikuluetan). Gurasoekin harreman egoki bat izatea eta familia testuinguruan estres eta gatazka gutxiago izatea biktima izateko arrisku gutxiagorekin erlazionatzen zela aurkitu zen lan hauetan. Erasotzaileen kasuan, aldiz, familian gertaera estresagarri bat ematea, hala nola, familiako kide bat ospitalizatua izatea, erasotzaile izateko arriskua igotzen zuela ikusi zen. Tesi hau osatzen duten lanetan lortutako emaitzak aurreko literaturarekin bat datoz, zeinak familiako zenbait aldagai bullying jokabidean parte hartzeko arrisku faktore izan daitezkeela erakutsi duten. Hauen artean, familian egoera estresagarri bat bizitzea (Connell et al., 2016; Pervanidou et al., 2019) edota familiako gatazka edo indarkeria pairatzea (Benavides Abanto et al., 2021; Hemphill et al., 2015; Zhu et al., 2018) eskola jazarpenean parte hartzeko arrisku faktore direla aurkitu da.

Azkenik, eskolako faktoreei eta faktore sozialei dagokionez, hauek tesiko hiru ikerketa lanetan aztertu ziren. Lehen ikerketa lanean *"Risk and Protective Factors for Bullying at 11 Years of Age in a Spanish Birth Cohort Study"* izenburupean, berdinekin harreman eta sostengu sozial hobeago bat izatea biktima zein erasotzaile izateko babes faktore gisa identifikatu zen. Eskola inguru hobe bat izatea, ordea, erasotzaile-biktima izateko babes faktore gisa identifikatu zen. Bigarren lanean (*"Do Prepubertal Hormones, 2D:4D Index and Psychosocial Context Jointly Explain 11-year-old Preadolescents' Involvement in Bullying?"*), eskola ingurua positiboagotzat hautematea, mutiletan biktima zein erasotzaile izateko arriskua gutxitzen zuela ikusi zen. Hirugarren lanean (*"Hair*

Cortisol as a Biomarker of Chronic Stress in Preadolescents: Influence of School Context and Bullying") harreman hauek ere ikertuak izan ziren. Lan honen emaitzek erakutsi zuten berdinekin arazoak izatea biktima izateko arriskua areagotzen zuela eta aldiz, eskola ingurua positiboagotzat hautematea biktima zein erasotzaile-biktima izateko arriskua gutxitzen zuela. Hiru ikerketa lanetan aurkitutako emaitzak aurreko ebidentziaren ildo beretik doaz, zeinak erakutsi duen alde batetik eskola klima egoki bat izatea (Moratto et al., 2017), berdinekin eta irakasleekin harreman ona izatea (Han et al., 2017) eta bizilagunekin harreman onak izatea (Bowes et al., 2009) bullying jokabidean inplikatua egoteko arriskua gutxitzen zuela.

Ikasleen kalifikazioek bullyingarekin zuten lotura ere aztertu zen. Tesia osatzen duen hirugarren azterlanean (*"Hair Cortisol as a Biomarker of Chronic Stress in Preadolescents: Influence of School Context and Bullying")*, funtzio exekutibo okerragoak izatea, berdinekin arazoak izatea eta bullying biktima izatea kalifikazio akademiko okerragoak izatearekin erlazionatzen zela ikusi zen, aurreko ebidentzian aurkitua den gisa (Pascual et al., 2019; Gomes et al., 2020). Bestalde, nahiz eta harremana aztertu, lan honek ez zuen eskola motak eta ikasle kopuruak bullyingean zuen eraginik frogatu. Eskolak duen egiturak bullyingarekin duen lotura gutxitan ikertu da eta erlazio honetan norabide argirik ikusten ez dela ondorioztatu da (Azeredo et al., 2015). Eskola motari dagokionez, aurreko ikerketa batek eskola publikotan eta bullying gehiago ematen dela aurkitu zuen (Machimbarrena & Garaigordobil, 2017). Ikasle kopuruari dagokionez, eskolan zeuden ikasle kopurua ez zen

bullyingarekin erlazionatzen, aldiz, ikasgela txikietan biktimazioa maiztasun gehiagoz ematen zela ikusi zen (Saarento et al., 2013).

Horrez gain, tesi honetako lehen eta bigarren azterlanetan (*Risk and Protective Factors for Bullying at 11 Years of Age in a Spanish Birth Cohort Study"* eta *"Do Prepubertal Hormones, 2D:4D Index and Psychosocial Context Jointly Explain 11-year-old Preadolescents' Involvement in Bullying?"* artikuluetan), sostengu sozialak aurrenerabeek bullyingean zuten partaidetzarekin lotura zuela aurkitu zen, baina ez zen ikusi gurasoek bizilagunekiko eta auzoarekiko zuten hautemateak jokabide honekin lotura duenik. Aurreko ebidentziak sostengu sozial egoki bat izatea eskola jazarpenean parte hartzearen aurrean babes faktore bat dela defendatzen du (Zych et al., 2019). Komunitateko faktoreei dagokionez, aurretik soilik bi lanek aurkitu zuten auzoan pobrezia maila altuak auzoan eta bizilagunekin harreman eskasak izatea bullying jokabidean inplikatuak egoteko arriskua handitzen zuela (Bowes et al., 2009; Foster & Brooks-Gunn, 2013).

5.2.2. Testosterona eta Kortisolak Bullyingarekin Duten Harremanari Buruzko Emaitzen Eztabaida

Urteetan zehar eskola jazarpena ikertzean gizabanakoaren eta honen inguruko aldagaiak hartu izan dira kontutan. Baina, azken hamarkadetan eskola jazarpena ikuspegi psikobiologiko batetik aztertzen hasi da. Honek, aldagai psikologiko eta biologikoek zenbait jokabideengan duten eragina aztertzeaz gain, hauen arteko loturak ezartzea baimendu du. Hain zuzen, prozesu biologikoek

jokabideen jatorri eta garapenean duten papera ulertzea ahalbidetuz.

Tesi honetan, faktore biologikoen barruan HPA eta HPG ardatzen menpeko hormonek bullying jokabidearekin duten lotura ikertu da. Horretarako bi ikerketa planteatu ziren. Alde batetik, tesi hau osatzen duen bigarren ikerketa lanean ("*Do Prepubertal Hormones, 2D:4D Index and Psychosocial Context Jointly Explain 11-Year-old Preadolescents' Involvement in Bullying?*") 2D:4D indizeak (jaio aurreko sexu hormona mailen erakusle) eta pubertaro garaiko testosterona eta kortisol mailek, aldagai psikosozialekin batera bullying garapenean zuten eragina aztertu zen. Bestetik, hirugarren ikerketa lanak (*"Hair cortisol as a biomarker of chronic stress in preadolescents: influence of school context and bullying"*), eskola inguruak orokorrean, eta zehazki bullyingak, aurrenerabeen estres kronikoan zuen eragina ikuskatzea zuen helburu. Bi ikerketa hauen bitartez hormonek bullyingean zuten eragina aztertzeaz gain, bullyingak kortisol mailetan duen eragina ere analizatu nahi izan zen.

Jaio aurreko hormona mailei dagokionez, 2D:4D indizearekin neurtuak, hauek bullyingarekin erlazionatzen ez zirela erakutsi zuten tesi honetako emaitzek. Nahiz eta aurreko ebidentziak 2D:4D indizeak agresibitatearekin lotura erakutsi duen (Hönekopp & Watson, 2011), indize honek bullying jokabidearekin duen lotura ikertzen duen lehen lana da honakoa. 2D:4D indizea eta bullyingaren artean harremanik ez aurkitu izana arrazoi desberdinengatik justifikatu daiteke. Alde batetik, laginaren

tamaina txikia da (n=302) agresibitatea eta 2D:4D indizearen arteko harremana aztertu duten aurreko ikerketekin alderatuz. Bestetik, lan honetako partaideak gazteagoak ziren, aurreko lanetan erabilitako laginekin alderatuz. Hala ere, 2D:4D indizearen eta bullyingaren arteko erlazioa aztertzen duen lehen lana izanik, ezin da baieztatu harreman hau ematen denik. Kontutan izan behar da agresibitatea eta 2D:4D indizearen arteko harremana aztertu zuen meta-analisi batek harreman honek efektuaren tamaina txikia zela erakutsi zuela (Hönekopp & Watson, 2011). Gerta liteke bullyinga bere baitan agresibitatea hartzen duen jokabide bat izanda ere, 2D:4D indizearekin harremanik ez erakustea. Etorkizunerako ikerketei begira, interesgarria litzateke 2D:4D indizea eta bullyingaren arteko harremanean adinak duen papera aztertzea eta harreman hau aztertzen duten lanetan lagin handiagoak erabiltzea.

Pubertaroko hormona mailen erakusle, HPA eta HPG ardatzen azken produktuak aztertu ziren, hots, testosterona eta kortisola. Aurreko ebidentziak nabarmendu du, hipotesi dualari jarraiki bi ardatz hauek elkarri eragiten diotela, batak bestearen aktibitatea inhibituz. Tesi hau osatzen duen bigarren lanean (*"Do Prepubertal Hormones, 2D:4D Index and Psychosocial Context Jointly Explain 11-year-old Preadolescents' Involvement in Bullying?"*), ordea, bi hormonen arteko elkarreragin positibo bat aurkitu zen. Honen arrazoia, HPA eta HPG ardatzek garapen fase desberdinetan duten aktibitatearekin lotuta egon daiteke. Izan ere, pubertaroan zehar HPA eta HPG ardatzak garapen fasean aurkitzen dira, eta ondorioz,

testosteronak eta kortisolak igoera bat jasaten dute (Ruttle et al., 2013).

Pubertaroko hormonei dagokionez, aurretik ikerketa bakarrak aztertu du testosterona mailek bullyingarekin duten lotura. Ikerketa honek erlazio hau sexuaren araberakoa zela erakutsi zuen. Hitzezko biktimizazioa jasaten zuten neskek testosterona maila baxuagoak zituzten, mutilek, aldiz, testosterona maila altuagoak (Vaillancourt et al., 2009). Tesi hau osatzen duen bigarren azterlanean ez zen frogatu testosterona zuzenean bullyingarekin erlazionatzen zenik. Hala ere, beste emaitza interesgarri bat aurkitu zen. Testosterona maila altuagoak zituzten neskek eskola ingurua negatiboago hautematen zutela. Eskola ingurua, bullyinga garatzen den ingurua da eta ikerketa lan honetan eskola ingurua ebaluatzeko erabilitako tresnak, irakasle eta ikasleekin zituzten harremanak hartzen zituen kontutan. Beraz, izan daiteke testosterona maila altuagoak zituzten neskek berdinekin harreman okerragoak izatea, eta hortaz, eskola ingurua ebaluatzen duen galdetegian puntuazio okerragoa izatea. Baina, harreman hauek ez izatea hain kaltegarriak bullyinga jasaten edo egiten dutela esateko bezain beste.

Kortisol mailek bullying jokabidearekin zuten erlazioa ere aztertu zen bigarren eta hirugarren azterlanetan. Bullyingak kortisolarekin duen erlazio bi bidetatik aztertu daiteke, jokabide honek bere baitan agresibitate eta indarkeria ekintzak hartzen baititu. Alde batetik, hipotesi dualak baieztatzen duen modura, dominantziarekin erlazionatutako jokabideen jatorrian HPA eta

HPG ardatzek duten papera landuz (Mehta & Josephs, 2010). Bestetik, indarkeria egoera ororen modura, eskola jazarpena ere egoera estresagarria izanik, kortisol mailekin zuzenean lotzen dela ikusi da (Vanaelst et al., 2012).

Alde batetik, tesi hau osatzen duen bigarren azterlanean (*"Do Prepubertal Hormones, 2D:4D Index and Psychosocial Context Jointly Explain 11-year-old Preadolescents' Involvement in Bullying?"*) kortisol mailek, testosterona mailekin batera bullyingean jokatzen duen aurresale papera aztertu zen. Ikerketa honen emaitzek erakutsi zuten kortisol maila baxuagoak erasotzaile izateko arriskua handitzen zutela, harreman hau soilik mutiletan agertuz. Aurreko ikerketatan bullyingak kortisolarekin duen lotura ikertzean, gehienek kortisola ondorio gisa ikertu dute eta ez dituzte HPA eta HPG ardatzen menpeko hormonak eta hauen arteko elkarreraginak aztertu. Tesiko bigarren lanean aurkitutako emaitzen ildo beretik ikerketa batzuk biktimizazioa eta kortisolaren arteko harremana sexuaren menpekoa dela erakutsi dute (Östberg et al., 2018; Vaillancourt et al., 2008). Eskola jazarpenak kortisolarekin duen lotura ikertu duten lanek biktimizazio rola ikertu dute batik bat, biktima ziren haurrek kortisol maila baxuagoak erakutsiz (Brendgen et al., 2017; Knack et al., 2011; Östberg et al., 2018; Peters et al., 2011). Erasotzaile rolari dagokionez, González-Cabrera et al.-ek (2017) bere lanean ziberjazartzaileek kortisolaren jariatze kurba lauagoak zituztela aurkitu zuten. Kortisol maila baxuak erasotzaile izatearekin zuen lotura hipotesi dualaren ikuspegitik azaldu daiteke. Honen arabera, testosterona maila altuak kortisol maila baxuarekin batera

agresibitate altuagoarekin erlazionatzen baitira (Mehta & Josephs., 2010).

Azkenik, hirugarren lanean (*"Hair Cortisol as a Biomarker of Chronic Stress in Preadolescents: Influence of School Context and Bullying"),* bullyingak izan ditzakeen ondorioetako bat aztertu nahi izan zen, zehazki, eskola jazarpenak sistema neuroendokrinoan eta HPA ardatzaren funtzionamenduan eduki ditzakeen efektua. Azterlan honetan ileko laginak erabili ziren azken hiru hilabetetan aurrenerabeek zituzten kortisol mailak estimatzeko. Nahiz eta eskola eragileek zuzenki ileko kortisolean eraginik ez izan, erasotzaile-biktima izatea ileko kortisol kontzentrazio altuagoekin erlazionatzen zela ikusi zen. Aurretik bi ikerketek aztertu zuten bullyingak kortisolarekin zuen harremana ileko laginak erabiliz. Lan batek bullying biktimizazioa eta ileko kortisol kontzentrazioaren arteko harremana ez lineala eta sexuaren araberakoa zela erakutsi zuen. Biktimizazio moderatua jasaten zuten mutilek kortisol maila baxuagoak zituzten ilean, aldiz, biktimizazio maila altuak bizitzen zituzten mutilek ileko kortisol kontzentrazio altuagoak zituzten (Ouellet-Morin et al., 2021a). Tesi hau osatzen duen hirugarren lanean bullying biktimizazioak ileko kortisol kontzentrazioetan zuen eragina frogatu ez zen arren, erasotzaile-biktima rolak ileko kortisol mailekin erlazioa zuela ikusi zen. Aipatu beharra dago Ouellet-Morin et al.,-en (2021a) lanean ez zela erasotzaile-biktima ikertu eta agian, rol hori ikertu balitz, biktimatzat hartu ziren haur batzuk erasotzaile-biktima izan zitezkeela pentsa daiteke. Biktimizazioa eta ileko kortisola aztertu zuen beste ikerketa lanak erakutsi zuen metatutako ezbeharrak

kontutan hartzerakoan harreman estatistiko esanguratsu bat zegoela, baina, berdinen arteko biktimizazioa ez zela modu zuzenean ileko kortisol mailekin erlazionatu (Ouellet-Morin, et al., 2021b). Bestetik, berriki egindako berrikuspen sistematiko batek ondorioztatu du, haurretan ezbehar sozial eta ileko kortisolaren arteko harremana ikertzen zuten lanek ebidentzia nahasia eta mugatua erakutsi dutela. Lotura hau ikertu duten lanen bi heren baina gehiagok ez zuen estatistikoki esanguratsua zen erlaziorik aurkitu. Gainerako lanek, asoziazio positibo nahiz negatiboa erakutsi dute, hau da, haurren ezbehar sozialen aurrean kortisol mailak igota edo jaitsita egon daitezkeela (Bryson et al., 2021).

Hortaz, kortisolak estresatzaile sozialekin orokorrean eta bullying egoerekin zehazki duen harremanak emaitza nahastuak erakutsi dituela ondorioztatu daiteke. Aurreko ebidentziak erakutsi du estresatzaile sozialek HPA ardatzaren hiper edo hipo erantzun bat gauzatu dezaketela. Erantzun nahastu hauen arrazoia estresatzaile motaren eta hau gertatzen den garaiaren araberakoa izan daiteke. Epe motzeko edota berriki gertatutako estresatzaileetan, HPA ardatzaren erantzun fisiologikoa hiperaktibatua egon ohi da. Kontrako aldetik, ordea, estresatzailea denboran urrun gertatzen denean edo presente ez dagoenean HPA ardatzaren hipoaktibitate bat ematen da. Erantzun hauek estres kronikoaren hipotesiarekin bat datoz, zeinak defendatzen duen estresatzailea hasten denean ardatzaren aktibazioa dagoela eta denbora aurrera doan heinean aktibitate hau gutxituz doala, kortisola maila normaletatik behera aurkitu arte (Liu & Doan, 2019; Miller et al., 2007).

Hirugarren ikerlanean eskola aldagaiek eta eskola jazarpenak kortisol mailekin zuten lotura aztertzeaz gain, aldagai askeen arteko harremana ere ikertu zen. Hauek horrela, ileko kortisol kontzentrazio altuagoak funtzio exekutibo okerrago batekin erlazionatzen zirela aurkitu zen. Aurretik soilik hiru lanek aztertu zuten harreman hau eta hauetatik bakar batek haurretan. Ikerketa honek ere asoziazio negatibo bat aurkitu zuen haurren kortisol mailen eta funtzio exekutiboaren artean, nahiz eta harreman hau ez izan estatistikoki esanguratsua (Piley Henessey et al., 2020).

Tesi hau osatzen duten azken bi azterlanetako emaitzetan oinarrituz, hormonek bulllyingarekin duten lotura partzialki konprobatu dela esan daiteke. Izan ere, testosteronak ez du harremanik erakutsi harremanik bullying jokabidearekin. Gainera, nahiz eta erasotzaile eta erasotzaile-biktima rola kortisolarekin erlazionatu den, biktima izateak ez du asoziaziorik erakutsi. Lotura hauek aurkitu ez izana eskola jazarpena ebaluatzeko erabilitako tresnarengatik edo partaideen adinagatik azaldu daiteke. Alde batetik, OBVQ galdetegiak ebaketa puntu oso zorrotzak ditu partaideek bullyingean duten partaidetza identifikatzeko. Bestetik, tesi honetako partaideak aurrenerabeak zirenez, hormona mailak garatzen ari zirela pentsa daiteke.

5.2.3. Mugak, Indarguneak eta Etorkizunerako Lanak

Ikerketa lan ororen moduan, tesi honetan zehar jorratutako lanek ere badituzte zenbait muga. Hasteko, eta agian nabarmenena, tesiaren erdigune den bullying jokabidea ebaluatzeko erabilitako tresna litzateke. OBVQ galdetegia urteetan zehar eta kultura

desberdinetan erabilia izan den arren, tesia osatzen duten lanetan, aurretik balidatuta ez zeuden euskarazko eta katalanezko bertsioak erabili ziren. Galdetegi honi aurrenerabeek erantzun behar ziotenez, eta hauek, eskola sisteman hizkuntza nagusitzat euskara eta katalana zituztenez, galdetegia hobeto ulertzeko asmoz hizkuntza hauetan betetzea proposatu zitzaien. Nahiz eta galdetegiaren ezaugarri psikometrikoak aztertu, eta hauek egokiak izan, tresna hau balioztatua ez egotea muga garrantzitsu bat izan daiteke. OBVQ galdetegiarekin jarraituz, hau bi azpieskalaz osatzen da, biktima eta erasotzaile rola aztertzen dituzten azpieskalak hurrenez hurren. Tesi hau osatzen duten lanetan, bi hauek konbinatuz erasotzaile-biktima rola ere aztertu zen, nahiz eta galdetegi hau rol hau ebaluatzeko zehazki sortuta ez egon. Ebaluazio tresnekin jarraituz Kidscreen-27 galdetegia ere ez zen aurretik euskaraz eta katalanez balidatua izan. Bestetik, aurrenerabeen hautemandako estresa ebaluatzen duen tresnarik ere ez da erabili, eta kortisolaren datuaz gain (neurri objektiboak) partaideek dituzten estres mailen hautematea ere nolabait jasotzea interesgarria litzateke.

Ebaluazio tresnekin erlazionatutako mugez haratago, ikerketa diseinuarekin lotutako beste zenbait muga ere identifikatu dira. Tesian INMA proiektuko partaideen datuak erabili dira, hain zuzen, Gipuzkoa eta Sabadelleko aurrenerabeen datuak, proiektua osatzen duten beste kohorteetan bullying fenomenoari buruzko informazioa jaso ez zelako. Horrenbestez, ikerketa hauetako partaideak Espainiako bi komunitate autonomotan zentratuak daudenez, emaitzak gizarteratzeko orduan, hauetan eman

daitezkeen ezaugarri sozioekonomiko eta soziokulturalak aintzat hartu beharko lirateke. Era berean, INMA proiektua urte jakin batzuetan jaiotako haurrek osatzen dute, ondorioz, aurrenerabeen adinean aldakortasun txikia ematen da, eta honek, bullying jokabidean hainbestetan aztertua izan den adinaren efektua behar bezala aztertzea galarazi zuen. Bestetik, tesian zehar landutako hiru lanetatik bitan 8 eta 11 urtetako faseetako datuak erabili diren arren, ikerketa honetan ez da ikuspegi longitudinala landu. Beraz, hormona mailek eta testuinguru psikosozialak bullyingarekin duten harremanaz hitz egin dezakegu, ez, ordea, kausalitatez.

Tesi honetan mugak aurkitu badaitezke ere, azpimarragarria da literatura zientifikoan aurki daitekeen ebidentzia zabaltzea bilatu nahi izan duela. Askotan, bullyinga estatus soziala lortu edo mantentzeko erabiltzen den jokabide bat da. Haur eta nerabeek epe luzerako ondorioak ikusteko gaitasuna ez dutenez, bullying jokabidea helburu zehatz bat lortzeko estrategia gisa erabiltzen dute. Hori dela eta, erabilgarria suertatzen zaien jokabide bat izanik, bullyinga, eskola inguruan prebalentzia nabarmenez ematea espero den jokabide bat da. Beraz, fenomeno inguruan ikertzen jarraitzea ezinbestekoa da, ezagutza hauetatik abiatuz haur eta nerabeei moldatutako mezu zehatzekin prebentzio eta interbentzio programak garatzeko.

Hauek horrela, tesi proiektu honek indargune batzuk ere badituela esan daiteke. Faktore biologikoen eragina bullyingaren ikerketara gerturatu dituzten lanak oso urriak izanik, tesi honek ikuspegi hori landu nahi izan du. Zentzu zabalenean esanda, tesi

honek bullyinga jorratu nahi izan du ikuspegi biopsikosozial bat erdigune izanik. Abiapuntu hau oinarritzat hartuz, hormona mailek bullying jokabidean zuten eragina aztertzeaz ez ezik, aldagai psikosozialek zuten lotura ere aztergai izan dute tesia osatzen duten hiru lanek.

Aldagai biologikoei dagokionez, pubertaro garaiko testosterona eta kortisol mailak neurtzeaz gain, 2D:4D indizearen informazioa ere jaso zen, jaio aurreko sexu hormonekiko esposizioak bullyingarekin loturarik zuen aztertzeko. Halaber, kortisola, listu laginez gain ileko laginen bitartez ere aztertu zen, bi teknika hauek informazio desberdina eskaintzen dutelarik. Lagin desberdin hauek erabiltzea kortisolak bullyingean zuen eragina eta alderantziz, bullyingak kortisolean zuen efektua aztertzea ahalbidetu zuten.

Aldagai psikosozialei erreparatuz, gizabanakoaren bizitzan eragiten duten gertuko inguruen informazioa jaso zen: familia, eskola eta komunitatearen inguruko informazioa, hain zuzen. Era berean, bullying fenomenoan partaideek hartu zitzaketen hiru rol esploratu ziren. Hain zuzen biktima, erasotzaile eta erasotzaile-biktima rolak. Bestalde, ikerketa hauek egiteko erabili diren galdetegi, test eta eskalak oso erabiliak izan dira aurretik. Bullyingari dagokionez, OBVQ galdetegiak bullyingaren definizio bat hartzen du bere baitan, eta honek partaideek bullyinga eta agresibitate isolatuaren artean desberdintzea baimentzen du. Gainera, bullying mota desberdinak hartzen ditu bere baitan (hitzezkoa, fisikoa, baztertzekoa, sexuala eta cyberbulliynga).

Bestetik, azpimarragarria da, funtzio exekutiboak ebaluatzeko erabilitako testak aipatzea. Aurretik egin diren ikerketetan funtzio exekutiboak gurasoen galdetegien bitartez ebaluatuak izan dira maiz, INMA proiektuan ordea, ordenagailuko test neuropsikologikoak erabili dira, modu zehatzeko eta fidagarriago batean informazioa jaso izana ahalbidetu zuena.

Azkenik, nabarmentzekoa da, ikerketa hauetan erabilitako eredu estatistikoak aldagai aske eta menpeko aldagaien arteko harremanak aztertzeaz ez ezik, aldagai askeen arteko erlazioak ere begiratzea baimentzen dutela. Modu berean, sexua tesian zehar jorratu diren hiru lanetan aintzat hartzea erabaki zen, bullyingarekin eta hormona mailekin duen erlazioagatik. Lehen lanean ikerketa aldagai bezala sartu zen, eta bigarren eta hirugarren lanetan analisiak sexuaren arabera egin ziren.

Tesi honetako muga eta indarguneak aztertu ostean, tesi hau lehen pausu bat dela esan daiteke. Etorkizunera begira INMA proiektuan ikerketa ildo honetatik jarraitzea espero da. Horretarako, 14 urteko fasean bullying eta cyberbullyingeko datuak jaso dira eta era berean, ile eta odol laginak bildu dira hormona mailak neurtzeko. Datu hauei esker eta 11 urteko faseko datuak izanik, ikuspegi longitudinala ezarriz, ematen diren erlazioak gehiago zehaztea bilatu nahi da.

Etorkizunera begira interesgarria litzateke antzeko lanak egitea, batez ere, ezaugarri sozioekonomiko eta soziokultural desberdinak dituzten laginak erabiliz. Eredu konplexuak erabiltzen jarraitzea lagungarria izan daiteke jokabide konplexu honetan

eragiten duten aldagai biologiko eta psikosozialek euren artean duten erlazioa ere ezagutzea baimentzen duelako. Kontutan izan behar da aldagai psikosozialak eta kortisol mailak nolabait aldagarriak direla eta beraz, hauek identifikatzea lagungarria suerta daitekeela prebentzio eta interbentzio programak diseinatzeko. Ezinbestekoa litzateke baita, etorkizuneko ikerketek tesi hau osatzen duten lanetan proposatutako ereduei zuzenketak egitea, edota hauek frogatzen saiatzea. Horrela, bullying jokabidearen ezagutza zabalagoa izango genuke eta interbentzioetan aldagai psikosozialetan oinarritzeaz gain, estresa ere landu genezake. Jakina da, bullyinga zuzenean estresarekin erlazionatzen dela, baina, era berean estresa bullyingarekin lotura izan dezaketen beste aldagai batzuekin ere erklazionatu daiteke, hala nola, funtzio exekutiboekin. Aspektu hauen konplexutasuna eta harreman hauen berezitasuna ikertzea ezinbestekoa litzateke haur eta nerabeen psikoneuroendokrinologia ulertzen jarraitzeko.

6. Erreferentziak

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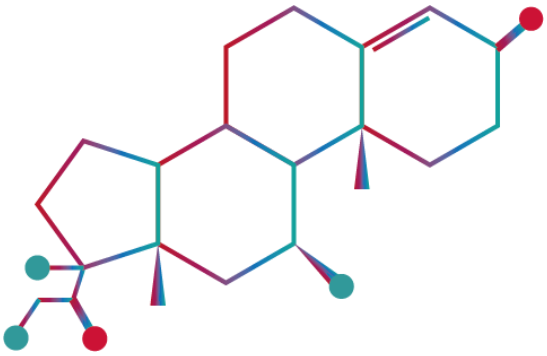
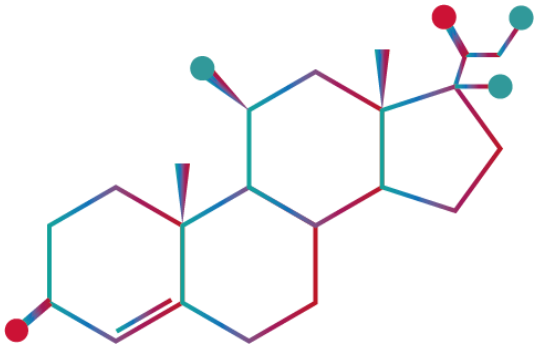


II. ATALA: ONDORIOAK.



7. Conclusions

In recent years, biological measures have been integrated into research on bullying, allowing the study of this behavior from a biopsychosocial perspective. Nonetheless, there is still a paucity of studies that examine jointly the influence of hormones and psychosocial factors on bullying. Hence, this thesis aimed to study bullying from a biopsychosocial perspective. Specifically, it investigated the joint relationship of HPA and HPG axis-dependent hormones and psychosocial factors with bullying behavior in preadolescents.

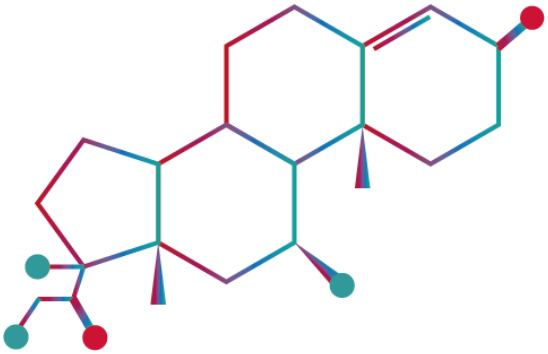
The thesis is built around three research papers that have shown that bullying behavior is indeed related to both psychosocial factors and hormonal levels. Regarding psychosocial factors, our results emphasized that, while behavioral problems were identified as risk factors for bullying behavior, having a supportive family and perceiving positive school and social environments protected against it.

Concerning hormones, two of the three studies explored whether hormone levels influence bullying, though their focus differed. One study examined the relationship of psychosocial variables and hormones involved in the HPA and HPG axis with bullying behavior, finding that hormonal and psychosocial factors were jointly associated with this type of behavior. Specifically, having lower cortisol levels in combination with a poorer social and school environment increased the risk of being a bully in boys. The second study looked at potential associations of the school

environment and bullying with preadolescents' chronic cortisol levels. According to the findings, our hypothesis was partially supported, only the bully/victim role being found to be related to cortisol levels.

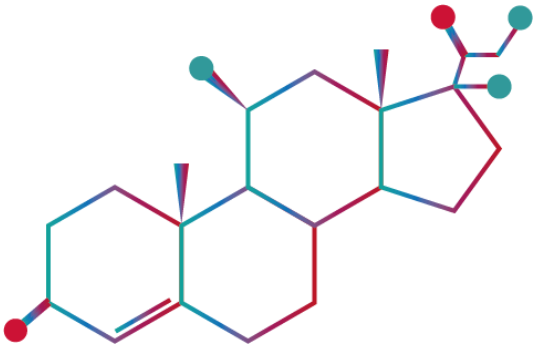
In summary, the thesis supports some of the hypotheses put forward, but not all the relationships investigated were found to be significant.

Bullying is one of today's greatest public health challenges during childhood and adolescence, and further research is needed to better understand how it affects physical and emotional development. The integration of biological measures into this research may not only improve our understanding of this aggressive behavior but also guide the development of programs for its prevention and management.



III. ATALA: ERANSKINAK.

Argitaratutako Lanak, Kongresuetan Aurkeztutako Lanak, Egonaldia eta Bestelako Eranskinak.



8. Argitaratutako Lanak

8.1. Artikulu Bilduma Bidezko Tesia Osatzen Duten Lanak

Atal honek tesia osatzen duten hiru lanak biltzen ditu. Jarraian, lan hauen erreferentzia bibliografikoak eta kalitatezko indizeak ageri dira.

1. Lana: "Risk and Protective Factors for Bullying at 11 Years of Age in a Spanish Birth Cohort Study."

Babarro, I.; Andiarena, A.; Fano, E.; Lertxundi, N.; Vrijheid, M.; Julvez, J.; Barreto, F.B.; Fossati, S.; Ibarluzea, J. (2020). Risk and Protective Factors for Bullying at 11 Years of Age in a Spanish Birth Cohort Study. *Int. J. Environ. Res. Public Health*, *17*, 4428, doi:10.3390/ijerph17124428.

Aldizkariaren Izena: International Journal of Environmental Research and Public Health.

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Risk and Protective Factors for Bullying at 11 Years of Age in a Spanish Birth Cohort Study

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Abstract: (1) Background: Bullying affects a large number of children worldwide. This study has two objectives, to provide data on the prevalence of bullying in Spain, and to identify risk and protective factors associated with bullying. (2) Methods: Participants were 858 eleven-year-old children. Bullying was assessed using a short version of the Olweus Bully Victim Questionnaire, and the following data were gathered to explore potential predictors: individual (inattention, behavior problems, attention deficit hyperactivity disorder symptomatology, traumatic life events), family-related (sociodemographic characteristics, family context, child-parent relations), school-related (school characteristics, peer and social support, school environment) and community-related data. (3) Results: 9.3% of the children were victims, 1.4% bullies and 1.6% bully-victims. Results showed that a higher level of attention deficit hyperactivity disorder symptomatology increased the risk of victimization, whereas having better relationships with parents and stronger social support were associated with a lower risk of victimization. Children having strong peer relationships and social support was also associated with less risk of perpetrating bullying. Finally, having behavior problems at 8 years of age was associated with being a bully-victim. (4) Conclusions: The findings emphasize the importance of studying all bullying predictors together, regarding three of the roles children may take in bullying situations.

Keywords: bullying; children; prevalence; risk; individual; family; community and school factors

1. Introduction

Bullying is defined as an aggressive behavior that happens in the school environment and is characterized by intentionality, repetitiveness and power imbalance between the bully and the victim [1]. It affects large numbers of children and adolescents worldwide, estimates indicating that between 8% [2] and 40% [3] of school students are involved in bullying. The variability in prevalence depends not only on the instrument used for evaluating the bullying, but also on the children's sociocultural

context. In a survey carried out between 2009 and 2010, assessing children in 38 European countries, the USA and Canada, the World Health Organization (WHO) found that the prevalence of bullying victimization ranged from 2% to 32%, and from 1% to 26% in the case of perpetration [4]. Large differences were also observed in the percentage of victimized children between European countries (Italy, England and Spain), in a cross-national European study by Ortega et al. (2012). Notably, their results showed that Spain has the lowest rates of victimization, particularly when talking about face-to-face bullying [5]. In Spain, García-García et al. (2017) found in their systematic review that the prevalence of bullying victimization was around 11.4% (range: 2.2%–29.01%) [6].

Due to the high prevalence and the impact it may have on people's lives, it is important to study the protective and risk factors associated with bullying. Some systematic reviews and meta-analyses have concluded that certain individual, family, school and community factors are related to the involvement that a person may have in bullying situations [7–12].

Sex and age have been the most studied individual factors. Concerning sex, many researchers have observed a higher percentage of boys involved in bullying as a victim [13,14], as a bully [14–17] and as a bully-victim [17]. On the other hand, some studies have shown that being a girl increases the risk of experiencing psychological or general bullying victimization [3,18]. Regarding age, children are most likely to be bullied between 11–13 years [19], and from this age, the rates tend to decrease. Most studies have observed that younger age increases the risk of being involved in bullying [3,20–22], though there is evidence questioning this association [15].

Apart from sex and age, other individual factors have been studied in relation to bullying. For example, it has been seen that poor motor skills increase the risk of being a victim [17,23], while good ones decrease the risk of being involved as a bully [17]. Having a neurodevelopmental disorder has also been studied in relation to child involvement in bullying. Compared to children with typical development for their age, a higher percentage of children with intellectual disability or autism spectrum disorder are involved in bullying [24,25]. Moreover, children with poor executive function [26,27] or with emotional and behavior problems [3,21,28–32] have also been found to be more likely to be involved in bullying.

Furthermore, certain family characteristics have been classified as protective or risk factors for bullying. One of the most studied family factors in relation to bullying is family structure. Specifically, living with both parents has been identified as a protective factor for children's involvement in bullying [14,30,33]. Parents' socioeconomic level has also been investigated, it being found that low family income increases the risk of being involved in bullying [17,23,34–37]. Additionally, poor parental mental health has been linked to bullying involvement [30,38], as have traumatic or stressful life events in the family context, such as the death [16] or chronic illness of a family member [2], these increasing the risk of being involved as a bully or as a victim, respectively. Finally, a punitive parenting style [39] and family conflict [13,40] or violence [3,20,36,41,42] have also been related to increases in children´s bullying involvement.

Regarding school-related factors, having a good relationship with peers and teachers [14] reduces the risk of being involved in bullying. On the other hand, the perception of an inappropriate school climate [43], feeling a lack of safety at school [33,44], attending a public school [36,45] and large school size [21] increase the risk of being involved in bullying. Further, community factors, such as having problems with neighbors [28], concentrated poverty in the neighborhood and change of residence or residential instability [36] increase the risk of being involved in bullying, as a victim or a bully-victim.

Involvement in bullying situations affects children's physical and psychological health. It has been found to be related to a wide range of problems, including poor mental health, substance abuse, somatic pain, being overweight or obese, poor academic achievement, loneliness [46], and even suicidal ideations [47]. This underlines the importance of identifying factors that increase the risk of being involved in bullying. To our knowledge, few empirical studies have analyzed the association individual, family, school and community predictors jointly have with bullying. And of these, only one focused on different roles that a child may have in bullying [13,33,36,48].

The present study has two objectives: first, to provide data on the prevalence of bullying in Spain based on the information provided by two cohorts of the INMA (INfancia y Medio Ambiente, from the Spanish for Children and the Environment, www.proyectoinma.org) project. Second, to identify individual, family, school and community related factors that may be associated with children´s involvement in bullying, considering three different roles: victim, bully and bully-victim.

2. Materials and Methods

2.1. Study Design and Participants

The study participants were children from the Gipuzkoa (Basque Country, Spain) and Sabadell (Catalonia, Spain) cohorts of the INMA project. This project collects data on children and their families in seven cohorts across Spain, and its main objective is to analyze the association between early exposure to environmental factors and children's physical and neuropsychological development and health [49]. Participants´ mothers were informed about the INMA project and recruited in their first trimester of pregnancy in health centers or hospitals of the public health system. To be included, they were required to meet the following inclusion criteria: being older than 16 years old, having the intention of giving birth in their referral hospital, not having communication problems, having a single pregnancy and not having followed an assisted reproduction program. Since recruitment, data have been collected in several follow-up phases: in the first and third trimester of pregnancy, at birth, and when the child was 14 months, 26 months, 4 years, 8 years and 11 years of age. The ethical committees of the hospitals in the regions involved approved the project and informed consent has been obtained from all participants in each of the phases. In this study, we used data from the 8-years´ and 11-years´ follow-up phases. In the 11-years´ follow-up, 880 children and their families were visited and respondents were excluded from the present analysis if bullying items were missing (n = 22), yielding a final sample of 858.

2.2. Bullying

Bullying was assessed using a short version of the Olweus Bully Victim Questionnaire (OBVQ) [50] at the 11 years' old follow-up, and children were asked to respond whilst thinking of the past 2 months. The OBVQ is a self-report instrument that has been widely used worldwide and which has shown satisfactory psychometric properties [51]. For the present study, we use a short version, which consists of a standardized definition of bullying and 16 questions. The first eight items refer to different victimization behaviors (physical, verbal, social, sexual and cyberbullying) and the second eight to physical, verbal, social, sexual or cyber harassment of another student. Items are rated on a 5-point Likert scale (0 "it hasn't happened to me in the past couple of months"–4 "it happens several times a week"). The OBVQ showed adequate internal consistency in the present sample: $\alpha = 0.81$ for the whole questionnaire, $\alpha = 0.82$ for victim scale and $\alpha = 0.67$ for bully scale. A dichotomized variable was created following the recommendations of Solberg and Olweus (2003). When participants answered "it happens 2 or 3 times a month" or more often to at least one of the items, they were categorized as victim, bully or bully-victim.

2.3. Risk and Protective Factors at Different Follow up

2.3.1. Eight-Year Follow-up

Strengths and Difficulties Questionnaire (SDQ) [52]: Parents were asked to complete the questionnaire to assess the general behavioral development of their children. The SDQ comprises 25 items in total, divided into 5 separate subscales: emotional symptoms, conduct problems, hyperactivity-inattention, peer relationship problems and prosocial behavior. The items are rated on a 3-point Likert scale (0 "not true"–2 "absolutely true"). In this study, the total difficulty score was used, which is generated by summing scores from all the scales except the prosocial scale, higher scores

indicating more behavior problems. This questionnaire showed adequate psychometric properties in a Spanish sample [53] and the internal consistency for the SDQ was acceptable in the present sample: $\alpha = 0.78$ for the total difficulty score used in the study.

Revised Conners' Parent Rating Scale (CPRS-R)—Short form [54]: Parents completed the short form of the CPRS-R. This scale assesses problematic behavior in children and consists of 27 items rated on a 4-point Likert scale (0 "not true at all"–3 "very much true") that yield scores for 3 subscales (Oppositional, Cognitive Problems/Inattention and Hyperactivity). For our study, we decided to use the ADHD index as a general measure of ADHD symptomatology. The Conners' scales have been widely used and have shown adequate psychometric properties in a Spanish sample [55]. In the present sample, the CPRS-R showed adequate internal consistency: $\alpha = 0.92$ for the ADHD index used in the study.

Haezi-Etxadi Family Assessment Scale 7-11 (HEFAS 7-11) [56]: Parents completed this instrument which assesses the quality of family context. It consists of 85 items divided into 5 subscales, namely: Promotion of cognitive and linguistic development, Promotion of socio-emotional development, Organization of the physical environment and social context, Parental stress and conflict, and Parental profile fostering child development. A higher score on the scale indicates a high quality of interactions in a family context. The psychometric properties of this scale are adequate [57] and in the INMA sample, the scale showed an acceptable internal consistency for each of the five subscales ($\alpha = 0.79$, $\alpha = 0.83$, $\alpha = 0.73$, $\alpha = 0.75$ and $\alpha = 0.80$, respectively). This information was only collected in the Gipuzkoa cohort.

Attentional Network Task (ANT) [58,59]: This computerized task involves identifying the direction of the central arrow of a row of five arrows. Children are asked to press, as quickly as possible, the right or the left button, depending on the direction of the central arrow. The aim of this test is to assess the attention, alertness, orientation and conflict networks. It consists of 128 trials divided into 4 blocks. We used the hit reaction time standard error (HRT-SE), which is considered a measure of inattentiveness; a high HRT-SE indicates highly variable reactions.

Social cohesion and trust: Parents were asked to complete an ad-hoc questionnaire based on the Sampson et al. (1997) questionnaire [60]. It is composed of 4 questions rated on a 5-point Likert scale (0 "completely agree" to 4 "completely disagree"). A higher score on these questions indicate lower perceived social cohesion and trust in the neighborhood. In our sample, the questionnaire showed acceptable internal consistency: $\alpha = 0.79$.

2.3.2. Eleven-Year Follow-up

At the 11-year follow-up, in order to obtain repeated measures, we used some of the same questionnaires as in the earlier follow-up phase, namely, the SDQ, CPRS-R and ANT. We assessed the correlation between the repeated measures at 8 and 11 years of follow-up, obtaining moderate to high significant correlations for the repeated measures of the three variables: SDQ, CPRS-R and ANT. Hence, for these questionnaires, we decided to use the variable which required less transformation due to skewness. Specifically, data from the 8-year follow-up were used in the case of the SDQ, and from the 11-year follow-up in the case of CPRS-R and ANT.

In addition to these repeated measures, we used the following questionnaires:

Cups Task Roulette Version Test [61]: This is a computer task, consisting of 54 trials, that assesses decision making by observing the number of risky decisions a child makes. In this task, the participant is presented with two wheels divided into segments of equal size and each associated with an amount of money. On each trial, the participant is asked to choose which wheel to spin, in order to gain, or avoid losing, money. After the response, the wheel selected is spun for 2 s, and then ends on the amount of money to be won or lost. For this study, we took into account the total number of risky decisions each child made.

Questionnaire Kidscreen-27 [62]: This self-reported questionnaire consists of 27 items that are rated on a 5-point Likert scale (1 "not at all"–5 "very much"). The items are divided into five

dimensions: Physical well-being, Psychological well-being, Peers and social support, Parents and autonomy, and School environment. In all cases, a higher score means a higher quality of the measured construct. The Spanish version of the Kidscreen-27 was validated, showing adequate psychometric properties [63,64]. The questionnaire showed acceptable internal consistency in the present sample for each of the subscales ($\alpha = 0.71$ for physical wellbeing, $\alpha = 0.72$ for psychological wellbeing, $\alpha = 0.73$ for parents and autonomy, $\alpha = 0.73$ for peer and social support and $\alpha = 0.70$ for school environment).

Ad-hoc sociodemographic questionnaire: Parents were asked to complete a set of questions to gather data on family characteristics, including family structure (number of siblings, living with one or both parents), and parents´ age, educational level and social class. Parents were also asked about stressful family events since the birth of the child: change of residence, change of school, parental separation, death of a relative and hospitalization of a relative. On the other hand, school characteristics (type of school and number of students in the school) were obtained by asking the school principals.

Table 1 shows the main characteristics of the questionnaires and tests used in the present study.

Table 1. Summary of instruments used.

Instrument	Type of Instrument	What is Assessed?	Reported by	Follow-up
Individual Predictors				
Strengths and Difficulties Questionnaire	Questionnaire	Behavior problems	Parents	8 years
Conners' Parent Rating Scale	Questionnaire	ADHD symptomatology	Parents	11 years
Attentional Network Task	Neuropsychological test	Attention	Children	11 years
Cups Task, Roulette Version	Neuropsychological test	Executive function	Children	11 years
Kidscreen-27: Physical and psychological well-being	Questionnaire	Level of physical activity, energy and fitness, and positive emotions and satisfaction with life	Children	11 years
Life stressful events	Questionnaire	Stressful events in the course of the child's life	Parents	11 years
Family predictors				
Haezi-Etxai Family Assessment Scale 7-11	Questionnaire	Family context	Parents	8 years
Kidscreen-27: parents and autonomy.	Questionnaire	Child's interaction with parents, autonomy, financial resources	Children	11 years
School and community predictors				
Kidscreen-27: peers and social support	Questionnaire	Child's relationship with friends and support received from them	Children	11 years
Kidscreen-27: school environment	Questionnaire	Child's relationship teachers and feelings about school	Children	11 years
Social cohesion and trust	Questionnaire	Social cohesion and trust	Parents	11 years

2.4. Data Analysis

Statistical analyses were performed using SPSS v. 25. (IBM, Armonk, NY, USA). In the first step (exploratory data analysis), we studied the symmetry of each relevant variable, transforming data, when appropriate, using Tukey's ladder of powers [65]. Further, we estimated the prevalence rates of bullying and measured the association between these and cohort and sex with Chi-square tests. In the second step, we applied logistic regression analysis [66], to build predictive models for the binary response variables: victim, bully, and bully-victim. In order to examine associations between the independent and dependent variables, bivariate analyses were performed using Chi-square test and

independent t-tests. The models were constructed using potential predictors that were associated with the dependent variables at $p < 0.10$ in the bivariate analysis. After testing for marginal effects, in order to do a consistent selection of predictors variables, "forward selection" and "backward elimination" stepwise methods were used. The models were built using the selected variables and including cohort, sex and age, due to the study design and findings in the previous literature. Finally, sensitivity analyses were performed, because two predictive variables were only assessed in the Gipuzkoa sample.

3. Results

3.1. Sample Description

The study sample consisted of 858 children (51% girls and 49% boys) of 11 years (M = 10.94; SD = 0.49; Min = 9.54; Max = 12.86), from the INMA project cohorts of Gipuzkoa (n= 376) and Sabadell (n = 482) (Appendix A). The descriptive analysis showed no statistically significant differences between the cohorts by sex, but that the children from Sabadell were older, on average, than those from Gipuzkoa (M = 11.04; SD = 0.60; M = 10.83; SD = 0.24; $p < 0.001$).

3.2. Prevalence of Bullying

Results showed that 9.3% of the children (n = 80) were involved as a victim, 1.4% (n = 12) as a bully and 1.6% (n = 14) as a bully-victim. When exploring differences in prevalence between subgroups, the results showed no significant differences in prevalence by sex (Chi-square (3) = 5.31; p = 0.15) or cohort (Chi square (3) = 0.39; p = 0.94).

3.3. Bivariate Findings

The examination of bivariate relationships showed that the following potential predictors were associated at $p < 0.10$ with being involved as a victim (Appendix B): behavior problems at 8 years (measured with SDQ), ADHD symptomatology at 11 years (measured with the CPRS-R), inattention at 11 years (measured with the ANT), physical and psychological well-being, relationship with parents and autonomy, relationships with peers and social support at 11 years (all measured with Kidscreen-27), parental stress and conflict and parental profile fostering child development at 8 years (measured with HEFAS 7-11), parents' social class, educational level, and availability of neighbors and trust in their neighborhood at 8 years.

As can be seen in Appendix C, only two variables were associated with being a bully ($p < 0.10$): peers and social support (measured with Kidscreen-27 at 11 years), and having had a family member hospitalized at any time in the child's life.

The results of the bivariate analysis between the predictor variables and the involvement in bullying as a bully-victim (Appendix D) suggested that the variables associated ($p < 0.10$) with being a bully-victim were: children´s age and sex, behavior problems at 8-years' follow-up (measured with the SDQ), ADHD symptomatology at 11-years´ follow-up (measured with the CPRS-R), inattention at 8 and 11-years' follow-up (measured with the ANT), psychological well-being and school at 11-years' follow-up (measured with Kidscreen-27), as well as the father´s social class, mother´s educational level and neighbors' availability.

3.4. Logistic Regression Models

In this analysis, three models were built, one for each dependent variable (victim/not involved, bully/not involved, and bully-victim/not involved).

Victims: Predictor Variables

Binary logistic regression was carried out in order to explore the way in which individual-, family-, school- and community-related factors might predict the involvement of the children in bullying as a victim. The following variables were selected for inclusion in the model using forward and backward

methods: ADHD symptomatology, parents and autonomy, and peers and social support. Finally, the model was adjusted for cohort sex and age (Table 2).

Table 2. Predictors of being a victim for the whole sample.

Variable	B	SE	*p*	OR	CI 95%	
Constant	−0.07	3.01	0.98	0.93		
Cohort: Gipuzkoa	0.21	0.26	0.42	1.24	0.74	2.07
Age	−0.17	0.27	0.54	0.85	0.50	1.44
Sex: Girl	0.06	0.26	0.82	1.06	0.63	1.79
ADHD symptomatology (Revised Conners' Parent Rating Scale) at 11-years' follow-up	0.40	0.10	0.00	1.49	1.22	1.82
Parents and autonomy (Kidscreen-27) at 11-years' follow-up	−1.14	0.37	0.00	0.32	0.16	0.66
Peers and social support (Kidscreen-27) at 11-years' follow-up	−0.01	0.01	0.00	0.99	0.98	0.99

Notes: B = beta; SE = standard error; OR = odds ratio; CI = confidence interval.

The model was statistically significant ($p < 0.01$) and explained 12.6% of the variance (R^2 Nagelkerke = 0.126). Results showed that higher ADHD symptomatology increased the risk of being involved as a victim of bullying at 11 years (OR = 1.49; 95% CI = 1.22–1.82), while having greater autonomy and better relationships with parents (OR = 0.32; 95% CI = 0.16–0.66) and having stronger peer relationships and social support (OR = 0.99; 95% CI = 0.98–0.99) were related to a lower risk of being involved as a victim in bullying situations.

In addition, following the same method, a model was built for the Gipuzkoa sample separately, including the same variables and the score for family ecology at 8 years (Table 3).

Table 3. Predictors of being a victim for the Gipuzkoa cohort.

Variable	B	SE	*p*	OR	CI 95%	
Constant	−7.23	9.01	0.42	0.00		
Age	0.69	0.82	0.40	1.99	0.40	9.97
Sex: Girl	0.04	0.40	0.93	1.04	0.47	2.29
ADHD symptomatology (Revised Conners' Parent Rating Scale) at 11-years' follow-up	0.28	0.15	0.07	1.32	0.98	1.78
Parents and autonomy (Kidscreen-27) at 11-years' follow-up	−1.31	0.56	0.02	0.27	0.09	0.80
Peers and social support (Kidscreen-27) at 11-years' follow-up	0.00	0.01	0.96	1.00	0.99	1,02
Parental stress and conflict (Haezi Etxadi Family Assesment Scale 7-11) at 8-years' follow up	0.00	0.00	0.05	0.99	0.99	0.99

Notes: B = beta; SE = standard error; OR = odds ratio; CI = confidence interval.

This model was statistically significant ($p < 0.01$) and explained 11.3% of the variance (R^2 Nagelkerke = 0.113). The results showed that having higher scores in family ecology, indicating lower levels of family stress and conflict, decreased the risk of being a victim of bullying (OR = 0.99, 95% CI = 0.99–0.99). Moreover, having a good relationship with parents (OR = 0.27; 95% CI = 0.09–0.80) was related to a lower risk of being a victim.

3.5. Bully: Predictor Variables

As can be seen in Appendix C, only two variables were associated with being a bully ($p < 0.10$): peers and social support and having had a family member hospitalized. As data on this latter variable were only collected for children in the Gipuzkoa cohort, we built one general model with the peers and social support variable, adjusted for cohort, sex and age (Table 4), and a different model for the Gipuzkoa sample (Table 5).

Table 4. Predictors of being a bully for the whole sample.

Variable	B	SE	*p*	OR	CI 95%	
Constant	−6.57	7.13	0.36	0.00		
Cohort: Gipuzkoa	0.21	0.62	0.73	1.24	0.37	4.15
Age	0.22	0.64	0.73	1.24	0.36	4.37
Sex: Girl	0.80	0.63	0.20	2.23	0.65	7.72
Peers and social support (Kidscreen-27) at 11-years' follow-up	−0.03	0.01	0.02	0.97	0.94	0.99

Notes: B = beta; SE = standard error; OR = odds ratio; CI = confidence interval.

Table 5. Predictors of being a bully for the Gipuzkoa sample.

Variable	B	SE	*p*	OR	CI 95%	
Constant	−18.85	17.68	0.29	0.00		
Age	1.28	1.61	0.43	3.58	0.15	83.35
Sex: Girl	1.93	1.16	0.09	6.92	0.71	67.37
Peers and social support (Kidscreen-27) at 11-years' follow-up	−0.05	0.04	0.16	0.95	0.88	1.02
Hospitalization of a family member	1.99	0.94	0.04	7.32	1.15	46.56

Notes: *B* = beta; *SE* = standard error; *OR* = odds ratio; *CI* = confidence interval.

This model was not statistically significant ($p = 0.07$) and it explained 7.3% of the variance (R^2 Nagelkerke = 0.073). The results suggested that having a good relationship with friends was associated with a lower risk of being a bully (OR = 0.97; 95% CI = 0.94–0.99).

In the case of the Gipuzkoa sample, the built model was statistically significant ($p = 0.04$) and it explained 17.4% of the variance (R^2 Nagelkerke = 0.174). The results showed that having had a family member hospitalized increases children's risk of being involved as a bully (OR = 7.32; 95% CI = 1.15–46.56).

3.6. Bully-Victim: Predictor Variables

As for the models of victims and bullies, variables were selected using forward and backward methods (inattention, behavior problems and school environment), and then the model was adjusted for cohort, sex and age (Table 6).

Table 6. Predictors of being a bully-victim for the whole sample.

Variable	B	SE	*p*	OR	CI 95%	
Constant	4.00	8.15	0.62	54.58		
Cohort: Gipuzkoa	0.55	0.62	0.37	1.74	0.52	5.80
Age	−1.23	0.73	0.09	0.29	0.07	1.22
Sex: Girl	−0.31	0.65	0.63	0.73	0.21	2.60
Inattention (Attentional Network Task) at 11 years' follow up	0.19	0.11	0.08	1.21	0.98	1.50
Behavior problems (Strengths and Difficulties Questionnaire) at 8 years' follow up	0.95	0.39	0.02	2.58	1.21	5.52
School environment (Kidscreen-27) at 11 years' follow-up	−0.39	0.20	0.05	0.68	0.45	1.01

Notes: B = beta; SE = standard error; OR = odds ratio; CI = confidence interval.

This model was statistically significant ($p < 0.01$) and it explained 20.6% of the variance (R^2 Nagelkerke = 0.206). The results showed that the only variable significantly associated with being a bully-victim was having behavior problems at 8 years (OR = 2.58; 95% CI = 1.21–5.52), whereas having a good school environment was related to being involved in bullying as a bully-victim (OR = 0.68; 95% CI = 0.45–1.01).

4. Discussion

Concerning the prevalence of bullying, the overall rate of involvement in our study was of 12.3%. Breaking this rate down, 9.3% of the participants were victims, 1.4% bullies and 1.6% bully-victims. The prevalence of bullying varies depending on the sociocultural and socioeconomic context and the instruments used for the detection and evaluation of bullying. The WHO carried out a study between 2009 and 2010, evaluating the involvement in bullying (using an item based on the OBVQ) of 11- to 15-year-old children from 38 countries in Europe, the USA and Canada. Specifically, in the 11-year-olds, it was observed that on average 13% of the participants were victims of bullying, whereas the prevalence of bullies was 8% on average [4]. In the same study, data in Spanish children indicated that 4% of girls and 8% of boys were victims, while 3% of girls and 7% of boys were bullies [4]. Garcia-Garcia et al. (2017), in a systematic review, including 32 papers on Spanish samples, found that overall, on average, 11.4% (between 2% and 29.01% depending on the study) of students in Spain with a mean age of 14.60 (SD = 0.70) were involved in bullying situations [6]. Two papers on bullying in the same Spanish regions as our study reported similar prevalence data. Specifically, regarding the Basque country, it was found that 13.2% were victims, 1.6% bullies and 2% bully-victims [45], while in a study in Barcelona (i.e., the same province as our sample from Sabadell in Catalonia), it was found that 10.7% of children were involved in bullying [67]. Hence, our data are similar to the recent prevalence data for bullying in Spain.

Although many previous studies have found that the involvement of preteens in bullying is sex dependent [14,15,18,22,34,36], in our study, we did not find a significant association between sex and the children's involvement in bullying, although we did observe a slighter higher percentage of girls involved as a bully and higher percentage of boys involved as a bully-victim. Some other studies have also found no consistent association [2,68]. Another personal variable that has been widely studied in relation to bullying is age. Many researchers have shown a higher risk of being involved in bullying at younger ages [3,20–22,26]. Unlike several other studies, we did not find any significant associations between age and being involved as a victim, a bully or a bully-victim. This may be due to the design of our study, there being very small differences in age between the participants.

Regarding the analysis of factors that could be associated with the involvement of boys and girls in bullying situations, in the case of the victims, we observed that more ADHD symptomatology as assessed with the CPRS-R at 11 years increases the risk of being a victim. Several studies have shown that children with behavior problems [69], such as externalizing problems [36], and more specifically, ADHD symptoms [70] or hyperactivity [29], have an increased risk of being involved in bullying situations as a victim. We also saw that a good relationship with friends and strong social support, as assessed with Kidscreen-27, decrease the risk of being involved in bullying situations as a victim at 11 years. Other researchers have found that a child having trust in school [71], a good relationship with classmates [14] and stronger peer and social support [72] decreased the risk of being involved in bullying situations. In the case of participants from Gipuzkoa, the sensitivity analysis showed that including family ecology (as assessed with HEFAS 7-11) at 8 years, the associations of bullying victimization with ADHD symptoms and with peer and social support found previously became non-significant. In addition, by including these factors, the variance explained by the model changed from 12.6% to 11.3%. Specifically, having greater stress and family conflict at 8 years increased the risk of being involved in bullying situations as a victim; on the other hand, a better perceived relationship with parents decreases the risk of being involved in bullying situations. Some studies have shown that good connectivity, understanding on the part of parents and good communication between parents and children are associated with decreases in the risk of being involved in situations of bullying [30,72], while family conflict increases the risk [13,40].

In the case of predictors of being a bully, we calculated two models, because the data about whether someone in the family had been hospitalized were only collected for participants from the Gipuzkoa cohort. As for being a victim, the relationship with peers and social support received from them, as assessed with Kidscreen-27, reduced the risk of being involved in bullying situations as a

bully. On the other hand, having experienced the hospitalization of a relative increases the risk of being a bully. In line with this, a previous study found that having a family member with a chronic disease increased children's risk of being a bully [2]. However, having a family member hospitalized was the unique of the studied stressful life events which showed an association with the implication children have in bullying. This could be due to the fact that our questions about stressful life events referred to the complete life of children rather than to a close period of their involvement in bullying.

Finally, the model for being a bully-victim showed that having behavior problems at 8 years (as assessed with SDQ) increased the risk of being involved in bullying. In line with this, symptoms of externalizing problems [28] in general, and of ADHD [32] in particular, have been associated with an increased risk of being involved in situations of bullying as a bully-victim.

Study Limitations and Strengths

This study is not without limitations. First, data on bullying were collected using a self-report and non-validated questionnaire; and second, compared to individual and family-related factors, relatively few school- and community-related factors have been considered. Third, despite the prevalence we observed being highly consistent with data from previous studies, our sample is relatively small for estimating the prevalence in Spain and it may not be representative, in that it only takes into account data from participants located in two geographical areas: Gipuzkoa and Catalonia. Moreover, it should be pointed out that few children were identified to be involved in bullying as a bully or a bully-victim, thus, the results obtained should be treated with caution. Finally, although we analyzed the impact behavior problems in general, and that ADHD, in particular, could have in bullying, we did not study other psychopathological dimensions, such as autism, which has been related to bullying in previous literature. Finally, the model for being a bully-victim showed that having behavior problems at 8 years (as assessed with SDQ) increased the risk of being involved in bullying. In line with this, symptoms of externalizing problems [28] in general, and of ADHD [32] in particular, have been associated with an increased risk of being involved in situations of bullying as a bully-victim.

Nevertheless, it should be highlighted that, to our knowledge, this is the first study in Spain that analyzes the association that individual, family, school and community predictors have with bullying, taking into account three of the roles children could take in bullying (victims, bullies and bully-victims). This is interesting, as it makes it possible to explore the way in which different factors affecting an individual may have an impact on the occurrence of particular events or development of a behavior like bullying. In addition, taking into account data from two follow-ups may provide clues as to who may be most at risk of being involved in this kind of situation, in relation to an individual´s family, social and school environment at an early age. Such information could help guide prevention programs, by identifying at-risk individuals. For future research, it would be desirable to continue studying the predictive factors together, analyzing the mediation and moderation effects of the different factors on participants who take different roles in bullying.

5. Conclusions

In our study, carried out with two cohorts of Spanish children and their families, the rate of bullying victimization was 9.3%, while 1.4% of the children were bullies and 1.6% bully-victims. In general, results indicate a considerable role of a child´s social skills, behavioral patterns, peer and family relationships in bullying situations. Our findings underline the importance of studying all influences on bullying together, and that identifying the factors associated with bullying might facilitate the prevention of bullying in at-risk children.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Description of the Sample.

Variable		%	Mean (SD)
Individual variables			
Sex	Female	51%	
	Male	49%	
Age			10.94 (0.49)
Behavior problems at 8 y (SDQ)			2.79 (0.91)
Inattention at 11 y (ANT)			13.70 (2.74)
ADHD symptomatology at 11y (CPRS-R)			2.38 (1.32)
Risky decisions at 11 y (Cups Task)			30.39 (9.28)
Phisical Wellbeing at 11 y (Kidscreen-27)			1.21 (0.44)
Psychologycal Wellbeing at 11 y (Kidscreen-27)			1.57 (0.39)
Family variables			
Mother age			43.19 (3.80)
Father age			45.29 (4.60)
Mother´s social class	Manual	35.6%	
	No manual	55.2%	
Father´s social class	Manual	57.4%	
	No manual	37.4%	
Mother´s study level	Primary	18.8%	
	Scondary	39.2%	
	Universitary	42%	
Father´s study level	Primary	29.9%	
	Scondary	42.9%	
	Universitary	27.2%	
Number of siblings			1.09 (0.51)
To be de oldest sibling	No	41.2%	
	Yes	58.8%	
Live with both parents	No	17.4%	
	Yes	82.6%	
Promotion of cognitive and linguistic development (HEFAS 7-11) at 8 y			67.02 (11.38)
Promotion of socio-emotional development (HEFAS 7-11) at 8 y			79.46 (7.84)
Organization of the physical environment and social context (HEFAS 7-11) at 8 y			86.74 (6.79)
Parental stress and conflict (HEFAS 7-11) at 8 y			77.26 (9.41)
Parental profile fostering child development (HEFAS 7-11) at 8 y			79.36 (8.79)

Table A1. *Cont.*

Variable		%	Mean (SD)
Change of residence	No	88.7%	
	Yes	11.3%	
Chage of school	No	96.5%	
	Yes	3.5%	
Parental separation	No	92.2%	
	Yes	7.8%	
Death of a relative	No	64.1%	
	Yes	35.9%	
Hospitalization of a relative	No	90.6%	
	Yes	9.4%	
Autonomy and parents at 11y (Kidscreen-27)			1.20 (0.37)
School and community variables			
Peers and social support at 11y (Kidscreen-27)			30.49 (30.23)
School environment at 11y (Kidscreen-27)			2.70 (1.37)
Type of school	Private	39.5%	
	Public	60.5%	
Stimate number of students in the school			586.69 (278.29)
A place the parents enjoy living in			1.77 (0.95)
It is easy to get practical help from neighboors			2.10 (0.91)
Most people can be trusted in the neighborhood			2.22 (0.97)
There are people I can turn to for advise			2.05 (0.94)

Appendix B

Table A2. Bivariate Analysis for Being a Victim.

Variable		Víctim	Not Involved	Víctim	Not Involved	*p Value*
		N (%)		Mean (SD)		
Individual variables						
Sex	Female	36 (45%)	402 (51.7%)			$p = 0.26$
	Male	44 (55%)	376 (48.3%)			
Age				10.90 (0.48)	10.95 (0.49)	$p = 0.41$
Behavior problems at 8 y (SDQ)				3.01 (0.85)	2.76 (0.91)	$p = 0.02$
Inattention at 11 y (ANT)				14.28 (2.78)	13.64 (2.73)	$p = 0.05$
ADHD symptomatology at 11y (CPRS-R)				3.03 (1.45)	2.32 (1.29)	$p = 0.00$
Risky decisions at 11 y (Cups Task)				31.58 (7.58)	30.27 (9.43)	$p = 0.24$
Phisical Wellbeing at 11 y (Kidscreen-27)				1.066 (0.43)	1.23 (0.44)	$p = 0.00$
Psychologycal Wellbeing at 11 y (Kidscreen-27)				1.38 (0.43)	1.59 (0.38)	$p = 0.00$
Family variables						
Mother age				42.61 (4.23)	43.25 (3.75)	$p = 0.15$
Father age				45.64 (5.27)	45.26 (4.53)	$p = 0.49$
Mother´s social class	Manual	38 (51.4%)	275 (37.9%)			$p = 0.02$
	No manual	36 (48.6%)	450 (62.1%)			
Father´s social class	Manual	48 (66.7%)	396 (56.5%)			$p = 0.09$
	No manual	24 (33.3%)	305 (43.5%)			
Mother´s study level	Primary	24 (30.4%)	135 (17.6%)			$p = 0.02$
	Scondary	27 (34.2%)	304 (39.7%)			
	Universitary	28 (35.4%)	327 (42.7%)			
Father´s study level	Primary	24 (34.8%)	209 (29.4%)			$p = 0.49$
	Scondary	30 (43.5%)	304 (42.8%)			
	Universitary	15 (21.7%)	197 (27.7%)			

Table A2. *Cont.*

Variable		Víctim	Not Involved	Víctim	Not Involved	*p Value*
		N (%)		Mean (SD)		
Number of siblings				1.17 (0.51)	1.08 (0.51)	$p = 0.30$
To be de oldest sibling	No	11 (31.4%)	132 (42.3%)			$p = 0.22$
	Yes	24 (68.6%)	180 (57.7%)			
Live with both parents	No	16 (20.3%)	131 (17.1%)			$p = 0.48$
	Yes	63 (79.7%)	635 (82.9%)			
Promotion of cognitive and linguistic development (HEFAS 7-11) at 8 y				66.71 (9.32)	67.05 (11.60)	$p = 0.87$
Promotion of socio-emotional development (HEFAS 7-11) at 8y				78.17 (8.74)	79.60 (7.74)	$p = 0.31$
Organization of the physical environment and social context (HEFAS 7-11) at 8y				85.07 (7.92)	86.93 (6.63)	$p = 0.13$
Parental stress and conflict (HEFAS 7-11) at 8y				72.94 (8.14)	77.74 (9.43)	$p = 0.00$
Parental profile fostering child development (HEFAS 7-11) at 8y				74.99 (12.08)	79.85 (8.22)	$p = 0.002$
Change of residence	No	34 (97.1%)	297 (87.9%)			$p = 0.99$
	Yes	1 (2.9%)	41 (12.1%)			
Chage of school	No	33 (94.3%)	327 (96.7%)			$p = 0.45$
	Yes	2 (5.7%)	11 (3.3%)			
Parental separation	No	30 (85.7%)	314 (92.9%)			$p = 0.13$
	Yes	5 (14.3%)	24 (7.1%)			
Death of a relative	No	23 (65.7%)	216 (63.9%)			$p = 0.83$
	Yes	12 (34.3%)	122 (36.1%)			
Hospitalization of a relative	No	31 (88.6%)	307 (90.8%)			$p = 0.66$
	Yes	4 (11.4%)	31 (9.2%)			
Autonomy and parents at 11y (Kidscreen-27)				0.99 (0.39)	1.22 (0.36)	$p = 0.00$
School and community variables						
Peers and social support at 11y (Kidscreen-27)				17.10 (25.15)	31.86 (30.86)	$p = 0.00$
School environment at 11y (Kidscreen-27)				1.92 (1.42)	2.78 (1.34)	$p = 0.00$
Type of school	Private	24 (36.9%)	274 (39.8%)			$p = 0.65$
	Public	41 (63.1%)	415 (60.2%)			
Stimate number of students in the school				537.27 (228.207)	591.33 (282.23)	$p = 0.14$
A place the parents enjoy living in				1.84 (1.11)	1.80 (0.94)	$p = 0.74$
It is easy to get practical help from neighboors				2.15 (1.09)	2.11 (0.92)	$p = 0.69$
Most people can be trusted in the neighborhood				2.48 (1.22)	2.21 (0.98)	$p = 0.02$
There are people I can turn to for advise				2.27 (1.19)	2.04 (0.94)	$p = 0.05$

Appendix C

Table A3. Bivariate Analysis for Being a Bully.

Variable		Bully	Not Involved	Bully	Not Involved	*p Value*
		N (%)		Mean (SD)		
Individual variables						
Sex	Female	8 (66.7%)	426 (50.7%)			$p = 0.27$
	Male	4 (33.3%)	415 (49.3%)			
Age				10.97 (0.30)	10.94 (0.49)	$p = 0.17$
Behavior problems at 8 y (SDQ)				2.80 (1.14)	2.79 (0.90)	$p = 0.98$
Inattention at 11 y (ANT)				13.92 (2.87)	13.69 (2.75)	$p = 0.78$
ADHD symptomatology at 11y (CPRS-R)				2.17 (1.25)	2..38 (1.32)	$p = 0.59$
Risky decisions at 11 y (Cups Task)				32.36 (8.27)	30.35 (9.29)	$p = 0.48$
Phisical Wellbeing at 11 y (Kidscreen-27)				1.14 (0.56)	1.21 (0.44)	$p = 0.60$
Psychologycal Wellbeing at 11 y (Kidscreen-27)				1.44 (0.47)	1.58 (0.39)	$p = 0.38$

Table A3. *Cont.*

Variable		Bully	Not Involved	Bully	Not Involved	*p Value*
		N (%)		Mean (SD)		
Family variables						
Mother age				43.64 (3.59)	43.18 (3.80)	$p = 0.68$
Father age				44.54 (4.52)	45.31 (4.58)	$p = 0.56$
Mother´s social class	Manual	3 (27.3%)	310 (39.4%)			$p = 0.41$
	No manual	8 (72.7%)	476 (60.6%)			
Father´s social class	Manual	7 (63.6%)	436 (57.4%)			$p = 0.68$
	No manual	4 (36.4%)	324 (42.6%)			
Mother´s study level	Primary	1 (8.3%)	158 (19.1%)			$p = 0.63$
	Scondary	5 (41.7%)	323 (39%)			
	Universitary	6 (50%)	347 (41.9%)			
Father´s study level	Primary	3 (27.3%)	228 (29.8%)			$p = 0.79$
	Scondary	4 (36.4%)	330 (43.1%)			
	Universitary	4 (36.4%)	207 (27.1%)			
Number of siblings				1.00 (0.71)	1.09 (0.51)	$p = 0.71$
To be de oldest sibling	No	3 (60%)	140 (40.9%)			$p = 0.39$
	Yes	2 (40%)	202 (59.1%)			
Live with both parents	No	2 (16.7%)	142 (17.1%)			$p = 0.97$
	Yes	10 (83.3%)	686 (82.9%)			
Promotion of cognitive and linguistic development (HEFAS 7-11) at 8 y				71.21 (7.42)	66.96 (11.42)	$p = 0.41$
Promotion of socio-emotional development (HEFAS 7-11) at 8y				77.82 (7.47)	79.48 (7.86)	$p = 0.64$
Organization of the physical environment and social context (HEFAS 7-11) at 8y				84.12 (8.67)	86.78 (6.76)	$p = 0.39$
Parental stress and conflict (HEFAS 7-11) at 8y				73.33 (9.69)	77.31 (9.41)	$p = 0.35$
Parental profile fostering child development (HEFAS 7-11) at 8y				74.29 (5.46)	79.43 (8.81)	$p = 0.19$
Change of residence	No	6 (100%)	325 (88.6%)			$p = 0.38$
	Yes	0 (0%)	42 (11.4%)			
Chage of school	No	6 (100%)	354 (96.5%)			$p = 0.64$
	Yes	0 (0%)	13 (3.5%)			
Parental separation	No	6 (100%)	338 (92.1%)			$p = 0.47$
	Yes	0 (0%)	29 (7.9%)			
Death of a relative	No	3 (50%)	236 (64.3%)			$p = 0.47$
	Yes	3 (50%)	131 (35.7%)			
Hospitalization of a relative	No	4 (66.7%)	334 (91%)			$p = 0.04$
	Yes	2 (33.3%)	33 (9%)			
Autonomy and parents at 11y (Kidscreen-27)				1.02 (0.37)	1.20 (0.37)	$p = 0.12$
School and community variables						
Peers and social support at 11y (Kidscreen-27)				10.25 (8.51)	30.89 (30.37)	$p = 0.02$
School environment at 11y (Kidscreen-27)				2.49 (1.41)	2.71 (1.37)	$p = 0.58$
Type of school	Private	4 (36.4%)	293 (39.6%)			$p = 0.83$
	Public	7 (63.6%)	447 (60.4%)			
Stimate number of students in the school				579.73 (220.35)	587.43 (279.55)	$p = 0.93$
A place the parents enjoy living in				1.44 (0.53)	1.81 (0.96)	$p = 0.26$
It is easy to get practical help from neighboors				2.33 (1.12)	2.11 (0.94)	$p = 0.47$
Most people can be trusted in the neighborhood				2.56 (1.014)	2.24 (1.01)	$p = 0.34$
There are people I can turn to for advise				2.33 (1.00)	2.06 (0.97)	$p = 0.39$

Appendix D

Table A4. Bivariate Analysis for Being a Bully-Victim.

Variable		Bully-Victim	Not Involved	Bully-Víctim	Not Involved	*p Value*
		N (%)		Mean (SD)		
Individual variables						
Sex	Female	4 (28.6%)	430 (51.3%)			$p = 0.09$
	Male	10 (71.4%)	409 (28.7%)			
Age				10.69 (0.43)	10.95 (0.49)	$p = 0.05$
Behavior problems at 8 y (SDQ)				3.65 (0.51)	2.78 (0.90)	$p = 0.00$
Inattention at 11 y (ANT)				15.56 (3.29)	13.66 (2.73)	$p = 0.01$
ADHD symptomatology at 11y (CPRS-R)				3.04 (1.08)	2.37 (1.32)	$p = 0.05$
Risky decisions at 11 y (Cups Task)				31.21 (5.21)	30.36 (9.33)	$p = 0.73$
Phisical Wellbeing at 11 y (Kidscreen-27)				1.15 (0.34)	1.21 (0.44)	$p = 0.62$
Psychologycal Wellbeing at 11 y (Kidscreen-27)				1.26 (0.33)	1.58 (0.39)	$p = 0.00$
Family variables						
Mother age				42.41 (4.16)	43.20 (3.79)	$p = 0.44$
Father age				44.42 (3.10)	45.31 (4.60)	$p = 0.47$
Mother´s social class	Manual	6 (54.5%)	307 (39.1%)			$p = 0.30$
	No manual	5 (45.5%)	479 (60.9%)			
Father´s social class	Manual	10 (90.9%)	433 (57%)			$p = 0.02$
	No manual	1 (9.1%)	327 (43%)			
Mother´s study level	Primary	6 (42.9%)	153 (18.5%)			$p = 0.06$
	Scondary	3 (21.4%)	325 (39.3%)			
	Universitary	5 (35.7%)	348 (42.1%)			
Father´s study level	Primary	8 (61.5%)	223 (29.2%)			$p = 0.33$
	Scondary	4 (30.8%)	330 (43.3%)			
	Universitary	1 (7.7%)	210 (27.5%)			
Number of siblings				1.00 (0.63)	1.09 (0.51)	$p = 0.68$
To be de oldest sibling	No	3 (50%)	140 (41.1%)			$p = 0.66$
	Yes	3 (50%)	201 (58.9%)			
Live with both parents	No	1 (7.1%)	143 (17.3%)			$p = 0.32$
	Yes	13 (92.9%)	683 (82.7%)			
Promotion of cognitive and linguistic development (HEFAS 7-11) at 8 y				66.41 (9.21)	67.03 (11.42)	$p = 0.90$
Promotion of socio-emotional development (HEFAS 7-11) at 8y				79.10 (10.20)	79.46 (7.82)	$p = 0.91$
Organization of the physical environment and social context (HEFAS 7-11) at 8y				86.60 (7.74)	86.74 (6.78)	$p = 0.96$
Parental stress and conflict (HEFAS 7-11) at 8y				74.77 (10.37)	77.30 (9.40)	$p = 0.51$
Parental profile fostering child development (HEFAS 7-11) at 8y				77.38 (8.38)	79.39 (8.80)	$p = 0.58$
Change of residence	No	7 (100%)	324 (88.5%)			$p = 0.34$
	Yes	0 (100%)	42 (11.5%)			
Chage of school	No	7 (100%)	353 (96.4%)			$p = 0.61$
	Yes	0 (0%)	13 (3.6%)			
Parental separation	No	7 (100%)	337 (92.1%)			$p = 0.44$
	Yes	0 (0%)	29 (7.9%)			
Death of a relative	No	5 (71.4%)	234 (63.9%)			$p = 0.68$
	Yes	2 (28.6%)	132 (36.1%)			
Hospitalization of a relative	No	6 (85.7%)	332 (90.7%)			$p = 0.65$
	Yes	1 (14.3%)	34 (9.3%)			
Autonomy and parents at 11y (Kidscreen-27)				1.08 (0.31)	1.20 (0.37)	$p = 0.22$
School and community variables						
Peers and social support at 11y (Kidscreen-27)				27.37 (32.95)	30.65 (30.24)	$p = 0.69$
School environment at 11y (Kidscreen-27)				1.78 (1.42)	2.72 (1.36)	$p = 0.01$
Type of school	Private	6 (60%)	291 (39.3%)			$p = 0.18$
	Public	4 (40%)	450 (60.7%)			
Stimate number of students in the school				575.5 (115.42)	587.48 (280.25)	p = 0.89
A place the parents enjoy living in				2.17 (1.12)	1.80 (0.96)	$p = 0.19$
It is easy to get practical help from neighboors				2.58 (1.24)	2.10 (0.93)	$p = 0.08$
Most people can be trusted in the neighborhood				2.00 (0.60)	2.24 (1.01)	$p = 0.41$
There are people I can turn to for advise				2.33 (1.16)	2.06 (0.96)	$p = 0.33$

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2. Lana: "Do Prepubertal Hormones, 2D:4D Index and Psychosocial Context Jointly Explain 11-Year-Old Preadolescents' Involvement in Bullying?."

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Do prepubertal hormones, 2D:4D index and psychosocial context jointly explain 11-year-old preadolescents' involvement in bullying?

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ABSTRACT

Background: Bullying is a type of aggressive behavior that occurs repeatedly and intentionally in school environments and where there is a power imbalance. The main objective of this study was to analyze the association that hormones and the psychosocial context jointly have with bullying behavior.
Method: Participants were 302 11-year-old preadolescents from the Gipuzkoan cohort of the INMA Project. Bullying was assessed using the Olweus Bully/victim Questionnaire. Prenatal sexual hormones were assessed by calculating 2D:4D ratio and in order to measure prepubertal testosterone and cortisol levels saliva samples were collected within a week of each other. Additionally, various psychosocial factors were evaluated: executive function, family context, school environment and social context. To analyze our complex hypothesis, six meta-models were tested using structural equation modeling.
Results: In relation to victims, results showed that victimization was related to worse school environment' perception in boys, and higher stress and conflict in the family in girls. In the case of their involvement in bullying as a bully, lower salivary cortisol levels, worse school environment' perception and lower peers and social support was related to being more frequently involved as a bully in boys, while having more family stress and conflict was related with being a bully in girls.
Conclusions: This approach makes it possible not only to explore the different biological and psychosocial factors affect bullying behavior, but also to explore associations between the predictor variables.

In general terms, human aggression is defined as any type of behavior intended to harm another person (Bushman & Anderson, 2001) and sometimes it is used in order to obtain status in the social group. One type of aggressive behavior that occurs typically during childhood and adolescence and tends to emerge in school environments is bullying, defined as a repetitive and intentional use of coercion, force, hurtful teasing or threats, to abuse, aggressively dominate or intimidate that tends to emerge in school environments and where there is a real or perceived power imbalance (Olweus, 1996).

In a survey carried out with children from different countries of Europe, the USA and Canada, the World Health Organization (WHO) concluded that prevalence of bullying victimization ranged between 2% and 32%, while perpetration varied from 1% to 26% (Currie et al., 2012). Data from a systematic review showed that in Spain prevalence of bullying victimization ranged between 2.2% and 29% (García-García et al., 2017) and particularly in the Basque country, a study showed that 13.2% of the participants were victims of bullying, 1.65% bullies and 2% were bullies/victims (Machimbarrena & Garaigordobil, 2018). Due to the high prevalence and the impact that bullying may have in peoples' life, it is now recognized as a public health problem (Craig & Harel, 2004).

Recent research indicates that the origin of aggressive behavior is multicausal and that biologic, social and cultural factors are continually interacting in it (Popova et al., 2018). Regarding psychosocial factors, some reviews and meta-analyses have found that individual-, school-, family- and community-related factors may act as risk or protective

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factors for bullying (Cook et al., 2010; Kljakovic & Hunt, 2016; Saarento et al., 2015; Suárez-García et al., 2019; Zych et al., 2019). Evidence has shown that those having a neurodevelopmental disorder, poor cognitive or executive function or emotional or behavioral problems are more likely to engage in bullying situations (Kljakovic & Hunt, 2016; Suárez-García et al., 2019). Certain family characteristics as low socioeconomic level, punitive parenting style and family conflict or violence have also been associated with children having higher rates of bullying involvement (Cook et al., 2010; Suárez-García et al., 2019; Zych et al., 2019). Finally, having a good school environment and a supportive social environment reduces the risk of being involved in bullying situations (Cook et al., 2010; Kljakovic & Hunt, 2016; Suárez-García et al., 2019; Zych et al., 2019).

As regards the biological factors that influence behavior, previous research have focused on the role that hormones, specifically testosterone and cortisol, play in two developmental periods. The prenatal and the pubertal are hormone-sensitive periods for the development of the nervous system in which hormones trigger structural changes that may influence behavior (Auyeung et al., 2013; Schulz et al., 2009; Vigil et al., 2016). Decades of behavioral endocrinology have demonstrated an association of the activity of the hypothalamic-pituitary adrenal axis (HPA) and the hypothalamic-pituitary-gonadal axis (HPG) with the behavior that underlies social interactions and relationships. A large literature has indicate that aggressive behavior is influenced by high levels of testosterone and low levels of cortisol (Popma et al., 2007; Terburg et al., 2009).

Testosterone is important for its role in sexual differentiation and reproductive activity in animals and humans; and it has been linked to aggression (Teisl, 2008). The role of testosterone during prenatal development is vitally important for early sexual differentiation of the brain (Romeo et al., 2002). One way to study prenatal androgen levels in general population using a noninvasive technique is using the 2D:4D ratio. The 2D:4D ratio is calculated by dividing the length of the second (index) finger by that of the fourth (ring) finger and it becomes relatively stable in early life. This ratio has been considered a prenatal indicator of sex hormones (Mikac et al., 2016), lower ratios reflecting higher androgens levels *in utero*.

Lutchmaya et al. (2004) first demonstrated a relationship between fetal testosterone and estradiol concentrations in amniotic fluid and the 2D:4D ratio, the association reaching significance when ratios were measured in the right hand. Years later, Ventura et al. (2013) also found an association between amniotic testosterone and digit ratio, being only statistically significant for girls. 2D:4D ratio has also been studied in relation to congenital adrenal hyperplasia (CAH) as this condition provides an opportunity to examine the effects of elevated androgen exposure during gestation. Hönekopp and Watson (2010) in their meta-analysis found that those subjects with CAH had lower ratios than their normal development counterparts. Recently, there has been some replication of these findings, but, the effect size was smaller than that found in previous meta-analyses (Richards et al., 2020). Finally, some other researchers failed to found association between the 2D:4D ratio and prenatal levels of sex hormones (Hollier et al., 2015; Nave et al., 2021; Richards et al., 2021). Despite the mixed results, the 2D:4D ratio is still used as an indicator of prenatal androgen exposure and it has been studied in relation to different behaviors, including aggressiveness. One meta-analysis found that the average effect size between the ratio and aggressive behavior was really small and only significant for males (Hönekopp & Watson, 2011). Whereas other authors did not find association between these prenatal testosterone and aggressive behavior (Hilgard et al., 2019; Joyner & Beaver, 2021).

Puberty is another period of important development, characterized by changes in individuals' biology, psychology and behavior. From a neurobiological perspective, it is a sensitive periods when the biological system develops and the vulnerability to stressful events increases (Lupien et al., 2009) and from a psychosocial perspective, is a period of interpersonal relationships where peer dynamics are of particular importance (Rodkin & Ryan, 2011). Pubertal testosterone has been studied in relation to aggressive behavior, showing mixed results. Some authors have found that higher testosterone levels are associated with higher levels of aggressiveness (Grotzinger et al., 2018; Sánchez-Martín et al., 2011), while others have found no association (Popova et al., 2018). Regarding the association between testosterone and bullying, one study found that in a sample of 12 years old preadolescents, bullied girls produced less testosterone than their non-bullied counterparts whereas bullied boys produced more testosterone than their non-bullied counterparts (Vaillancourt et al., 2009).

Other hormone studied in relation to aggressive behavior is cortisol, the final product of the HPA axis and which regulates the acute stress response (Teisl, 2008). A recent systematic review concluded that victimization was consistently associated with cortisol (Kliewer et al., 2019). Most of the studies found that children involved in bullying or cyberbullying showed lower levels or blunted pattern of cortisol (González-Cabrera et al., 2017; Östberg et al., 2018; Peters et al., 2011), however, some studies did not found any association (Vaillancourt & Sunderani, 2011; Williams et al., 2017). Further, Vaillancourt (2009) concluded that this association was sex dependent, being occasionally bullied was associated with higher cortisol levels in boys, but with lower cortisol levels in girls.

Although testosterone and cortisol have independently shown associations with human behavior, the HPA and HPG axes have shown to be related. The dual-hormone hypothesis posits that testosterone is related to aggressive behavior when cortisol levels are low (Dabbs et al., 1991; Mehta & Josephs, 2010). A review and a meta-analysis concluded that the association between testosterone and cortisol on status-relevant behavior was statistically significant, but that its effect size was small (Dekkers et al., 2019; Grebe et al., 2019).

Apart from being puberty a period of many biological changes, early adolescence is a period in which children develop new interests and characteristics and it is expected that they develop new friendships (Georgiou, Ionnou, & Stavrinides, 2017). In general, peer dynamics are positive during this period but sometimes children and adolescents become involved in bullying situations. Considering bullying is a form of aggression whose peak occurs between the ages of 11 and 13 (Eslea & Rees, 2001), and that this coincides with first stages of puberty (Vigil et al., 2016), we are interested in analyzing testosterone and cortisol levels in relation to bullying, taking into account other psychological factors.

Therefore the main objectives of the present study were (1) to establish an association between prenatal and pubertal hormone levels (testosterone and cortisol) with the different roles that preadolescents take in bullying (victim, bully, bully/victim); (2) to study the relationship between the different psychosocial predictors (impulse control, family context, peer support, school environment) and the involvement that preadolescents have in bullying and (3) to explore the relationships that the different predictors show between each other.

1. Method

1.1. Participants

The study participants were 302 preadolescents from the Gipuzkoan (Basque Country) cohort of the INMA Project (Children and the Environment, www.proyectoinma.org). This project gathers data on children and their families in seven cohorts across Spain with the goal of analyzing the association between early environmental exposure and children's health and development (Guxens et al., 2012). The participants' mothers were informed about the INMA project and recruited in their first trimester of pregnancy in health centers or hospitals of the public health system. Since recruitment, data have been collected in several follow-up phases. The ethics committees of the hospitals in the region involved approved the project and informant consent was obtained for all participants in each of the phases. In this study, we used

data from the 8-year and 11-year follow-up phases. In the 8-year follow-up we visited 397 families and 379 in the 11-year follow-up. Of these, 77 were excluded due to missing data for one or more important variables. Complete information for all variables included in the meta-model was available for 302 cases (144 boys and 158 girls).

1.2. Instruments

1.2.1. Bullying

Bullying was assessed using a short version of the Olweus Bully Victim Questionnaire (OBVQ) (Olweus, 1996) at the 11-year follow-up. In this study, we used a version consisting of a standardized definition of bullying and 16 questions to which preadolescents were asked to respond thinking of the last 2 months. The first eight items refer to experiences of victimization and the second eight to the context of bullying others. Items are rated on a 5-point Likert scale (0 "it hasn't happened [to me]", 4 "it happens [to me] several times a week").

Following the recommendations of Solberg and Olweus (2003) those preadolescents who scored two or more in the Likert scale at least in one of the 8 questions of the first subscale were identified as victims, and those who scored higher than two in at least one of the 8 questions that conformed the second subscale, were identified as bullies. A third role (bully/victim) was created for those preadolescents who presented scores higher than two in both subscales. After being preadolescents classified into one of these roles, three categories were created based on bullying frequency: never involved, occasionally involved, and frequently involved (Vaillancourt et al., 2008). The OBVQ showed adequate internal consistency in the sample of the INMA project: $\alpha = 0.81$ for the whole questionnaire, $\alpha = 0.81$ for the victim scale and $\alpha = 0.67$ for the bully scale.

1.2.2. 2D:4D ratio

We measured the 2D:4D ratio at the children's school at the time of their 11-year follow-up. One trained researcher obtained images of all the preadolescents' hands following an ad hoc protocol based on the recommendations given by Mikac et al. (2016) and using a portable scanner (Epson Perfection V39). Once the images were obtained, these were measured using the AutoMetric computer program. We collected data of both right and left 2D:4D index and the correlation for data of both hands was substantial and statistically significant ($r = 0.652$; $p = 0.0001$) (Appendix 1). In light of this correlation, we only used data from one hand based on a meta-analysis of Hönekop & Watson (2010), which indicated that sex differences in 2D:4D were greater in the right hand than in the left.

1.2.3. Prepubertal hormone levels: Testosterone and Cortisol

At the 11-year follow-up, to assess testosterone and cortisol levels, two saliva samples were collected from each child within a week of each other and between 8 and 10 am, in order to avoid changes in hormone levels due to diurnal fluctuations. Preadolescents and their parents were asked to collect these saliva samples at home; they received a study pack with standardized written instructions and a kit with clean containers for collecting the samples by passive drool. Preadolescents were asked to avoid eating, drinking or brushing their teeth for 1 h prior to sample collection and not to attend the dentist in the 24 h before taking the samples.

Samples were analyzed in the Psychobiology Laboratory (Faculty of Psychology - University of the Basque Country). Saliva samples were centrifuged at 3000 rpm for 15 min to remove mucins and were stored at − 80ºC until analysis. All samples were assayed in duplicate using an enzyme immunoassay kit (Salimetrics, State College, PA, USA). Plates were read at 450 nm for both hormones using a Synergy™ HT plate reader (Bio-Tek Instruments, Inc., Winooski, VE, USA). The average inter-assay coefficient of variation (CV) was less than 5% for both hormones measured, and the intra-assay CV was less than 10% for cortisol and 12% for testosterone levels, relative to control samples. Samples with a CV> 10% were reanalyzed. Samples were excluded if the hormone levels were below the limit of detection or were above or below three standard deviations from the mean. The sensitivity of the kit was < 0.007 μg/dL for cortisol and < 1.0 pg/mL for testosterone. For the statistical analyses, the mean of both measures was calculated for each hormone.

1.2.4. Risky decision making: cups task roulette version

At the 11-year follow-up preadolescents' decision making was evaluated using this computer task, an adapted version of the Cups Task (Levin et al., 2007). It consists of 54 trials that assess decision making by observing the number of risky choices a child makes. In this task, the participant is presented with two wheels divided into segments of equal size and each associated with an amount of money. On each trial, the participant is asked to choose which wheel to spin, in order to gain or avoid losing money. After the response, the wheel selected is spun for 2 s, then ends on the amount of money to be won or lost. One wheel is riskless: each segment has the same small amount of money associated with it ($ ± 1.00). The other wheel represents a risky choice: only one segment has an amount associated with it ($ ± 2.00, $ ± 3.00, or $ ± 5.00) while the other segments have $0.00. Both wheels have the same number of segments, which vary between 2, 3 and 5; thus, when selecting the risky wheel, chances were either 50%, 33%, or 20% that the wheel will stop on the segment associated with an amount of money. Half trials are gains trials (i.e., with a positive amount of money), the other half are loss trials (with a negative amount of money). The entire task comprises 54 trials. In each condition (gain and loss), there is an equal number of risk- advantageous, risk-disadvantageous, and equal expected value (EV) trials. For this study, we took into account the overall score of total number of risky choices made by each child, a higher number indicating poorer executive function.

1.2.5. Quality of family interactions: Haezi-Etxadi Family Assessment Scale (HEFAS) (Barreto-Zarza et al., 2021)

At the 8-year follow-up parents completed this instrument which assess the quality of the family context. It consists of 85 items divided into 5 subscales, namely: Promotion of cognitive and linguistic development, Promotion of socio-emotional development, Organization of the physical environment and social context, Parental stress and conflict, and parental profile fostering child development. A higher score on the scale indicates a high quality of interactions in a family context. In this study, we only used the parental stress and conflict subscale, which we considered the most useful among the five subscales. One reason is that previous literature has demonstrated that family conflict or violence is associated with bullying behavior. Additionally, the family context can cause stress and, as a result, lead to elevated cortisol levels in children. The psychometric properties of this subscale are adequate, the internal consistency for each of the five subscales, being $\alpha = 0.75$ for the stress and conflict subscale used in this study.

1.2.6. Social context: Kidscreen-27 questionnaire (Kidscreen-27)

At the 11-years follow-up preadolescents completed this self-reported questionnaire which assesses health-related quality of life in children and adolescents. The scale consists of 27 items divided into 5 subscales, assessing physical well-being, psychological well-being, peers and social support, autonomy and parent relations, and school environment. Each item is rated on a 5-point Likert scale (1 "never/not at all"– 5 "always/extremely"). In all cases, a higher score means a better quality of life in the dimension measured. The Spanish version of the Kidscreen-27 was validated showing adequate psychometric properties (Quintero et al., 2011). The questionnaire showed acceptable internal consistency in the present sample for each of the subscales ($\alpha > 0.70$). For this study, we used two of the five subscales, namely, peers and social support and school environment.

Note: the resulting dataset is available for interested researchers, upon reasonable request to the corresponding author.

1.3. Data analysis

R software v. 4.0.0 (R Core Team, 2020) was used to conduct all statistical analyses. We used structural equation modeling (SEM) to test specified model based in our theoretical framework (Fig. 1) as this type of modeling allows the analysis of complex causal hypotheses (Duncan, 1975; Heise, 1975). SEM assumes linearity in the relationships between continuous variables and Gaussian error terms. For this reason, as suggested by Tukey (1977), we square root-transformed pubertal testosterone and cortisol levels. This was sufficient to ensure the linearity of relationships and, therefore, the suitability of the global estimation method.

After making descriptive analysis, we carried out bivariate analysis. On the one hand, independent t-test was used to assess differences by sex. On the other hand, Pearson correlation was used to test the association between the independent variables, as all were continuous variables. Kendall rank correlation was used to test the association between the independent variables and the dependent ones, because these last were ordinal in nature. Finally, we carried out the structural equation modeling and obtained global estimates via the maximum likelihood method. Specifically, the said metamodel was fitted and tested using the sem() function in the R package *lavaan*, with the <ordered> argument in this function to specify that the tested responses are ordinal. Data-to-model consistency is evaluated using a chi-square test and two goodness-of-fit measures were used: the comparative fit index (CFI) and the root mean square error of approximation (RMSEA) (Kenny & Kaniskan, 2015). The final models were accepted only when all three of the following conditions were met: chi-square test p-value > 0.05, CFI > 0.95, RMSEA p-value > 0.05.

2. Results

2.1. Bullying prevalence

The descriptive analyses showed that in terms of severity, the prevalence of bullying was as follows: 9.6% were considered victims of bullying (girls: 8.9%; boys: 10.4%) as they were frequently bullied, and a further 13.9% of the participants were occasionally bullied (girls: 17.1%; boys: 10.4%). On the other hand, 1.7% were classified as frequent bullies (girls: 2.5%; boys: 0.7%) and 7.6% as occasional bullies (girls: 7%; boys: 8.3%). Lastly, 1.7% of the sample were considered frequent bully/victims (girls: 1.3%; boys: 2.1%) and 8.3% occasional bully/victims (girls: 4.4%; boys: 12.5%).

2.2. Descriptive analysis

Table 1 reports the descriptive analysis of the independent variables and sex differences in each. Regarding hormone levels, results showed that boys had lower 2D:4D ratios than girls, indicating higher prenatal exposure to androgen levels. On the other hand, girls showed higher prepubertal levels of cortisol. Considering individual factors, boys scored higher in making risky choices. Finally, regarding social factors, girls scored higher in school environment than boys. No sex differences were found in peers and social support, or family stress and conflict.

2.3. Bivariate findings

Pearson correlations were performed to explore the relationship between the predictor variables (Table 2), while Kendall rank correlation coefficient test was used to analyze the associations between each predictor and the dependent variables (Table 3). Concerning associations between the predictor variables, results showed that in boys, 2D:4D ratio was associated negatively with family stress and conflict scores, that is, higher prenatal androgens levels in boys were related to less parental stress and conflict. Moreover, in girls, 2D:4D ratio was positively associated with cortisol levels, that is, less prenatal androgen' exposure was related to higher prepubertal cortisol levels and prepubertal testosterone was negatively related to school environment. For both sexes, we found a positive association between salivary testosterone and salivary cortisol and a positive association between the two subscales of the Kidscreen-27: school environment and peers and social support.

Bivariate analysis between the predictor variables and the dependent variables showed that only one predictor was significantly associated with victim propensity in girls: family stress and conflict. In boys, school environment was the only significant predictor related to victimization. In the case of bully propensity, none of the predictors was significantly associated with the dependent variable in girls, but peers and social support was related to being a bully in boys. Lastly, in girls 2D:4D ratio and peers and social support were related with bully/victim propensity.

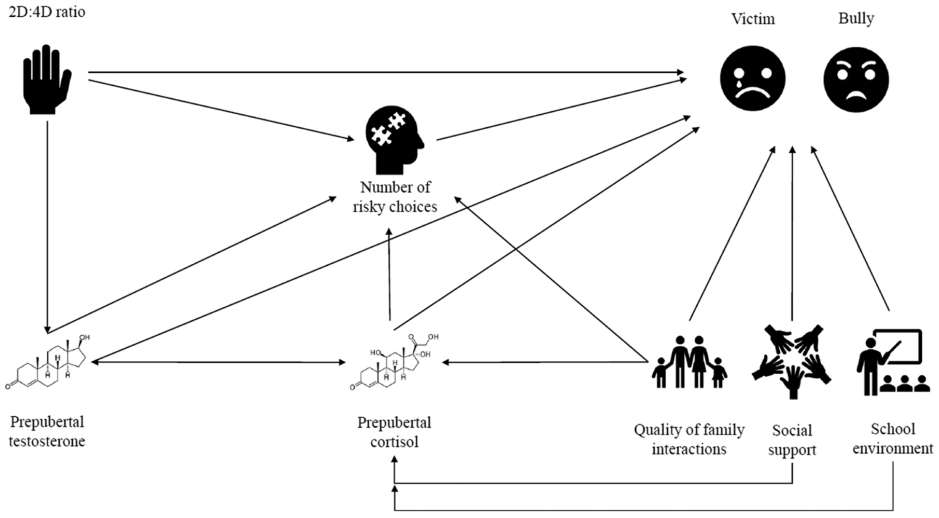

Fig. 1. Metamodel summarizing the hypothesized relationships among <biological> and <psychosocial> variables.

Table 1
Descriptive statistics of the seven quantitative independent variables for the whole sample, together with Welch two sample t-test for the difference between boys and girls.

Variable	Sex	*n*	Min	Max	Mean	SD	Difference	95% C.I. L. B.	95% C.I. U. B.	*t*-value	df	*p*-value	*Cohen's d*
2D:4D ratio	B	144	0.864	1.054	0.956	0.038	–	–	–	–	–	–	
	G	158	0.867	1.088	0.970	0.036	–	–	–	–	–	–	
	–	302	0.864	1.088	0.963	0.038	-0.01	-0.02	-0.01	-3.42	300.0	0.001	0.38
Salivary testosterone (pg/mL)	B	144	7.64	93.94	29.12	14.43	–	–	–	–	–	–	
	G	158	6.69	94.46	32.08	16.15	–	–	–	–	–	–	
	–	302	6.69	94.46	30.67	15.40	-0.25	-0.55	0.05	-1.62	300.0	0.106	0.19
Salivary cortisol (μg/dl)	B	144	0.06	0.90	0.28	0.13	–	–	–	–	–	–	
	G	158	0.05	0.90	0.33	0.16	–	–	–	–	–	–	
	–	302	0.05	0.90	0.31	0.15	-0.04	-0.07	-0.01	-2.54	300.0	0.011	0.34
Number of risky choices (Cups Task)	B	144	5.0	52.0	33.2	8.5	–	–	–	–	–	–	0.36
	G	158	10.0	51.0	29.9	9.6	–	–	–	–	–	–	
	–	302	5.0	52.0	31.48	9.2	3.29	1.23	5.35	3.29	300.0	0.002	
Peers and social support (KidScreen-27)	B	144	-0.05	4.23	2.52	1.10	–	–	–	–	–	–	
	G	158	-0.05	4.23	2.64	1.17	–	–	–	–	–	–	
	–	302	-0.05	4.23	2.58	1.13	-0.13	-0.37	0.14	-0.87	300.0	0.386	0.11
School environment (KidScreen-27)	B	144	-1.16	4.65	2.55	1.40	–	–	–	–	–	–	
	G	158	-0.54	4.65	2.91	1.32	–	–	–	–	–	–	
	–	302	-1.16	4.65	2.74	1.37	-0.36	0.16	-0.66	-2.26	300.0	0.024	0.26
Family stress and conflict (HEFAS 7–11)	B	144	44.44	98.61	77.47	9.14	–	–	–	–	–	–	
	G	158	55.56	98.61	76.85	9.72	–	–	–	–	–	–	
	–	302	44.44	98.61	77.15	9.44	0.61	-1.52	2.75	0.56	300.0	0.572	0.06

Note: B = boys; G = girls; Min = minimum; Max = maximum; SD = Standard Deviation; 95% CI LB = 95% confidence interval lower bound; 95% CI UB = 95% confidence interval upper bound; df = degrees of freedom.

Table 2
Associations between the six structural equation model quantitative variables considered in the structural equation metamodel.

Boys		Number of risky choices	Peers and social support	School environment	Family stress and conflict	Salivary testosterone	Salivary cortisol
	2D:4D ratio	0.104	0.055	0.039	**-0.312**	0.059	-0.076
	Number of risky choices		-0.059	-0.105	-0.018	0.067	0.130
	Peers and social support			**0.225**	-0.005	0.127	0.126
	School environment				-0.103	-0.064	-0.086
	Family stress and conflict					0.003	-0.030
	Salivary testosterone						**0.530**
Girls		Number of risky choices	Peers and social support	School environment	Family stress and conflict	Salivary testosterone	Salivary cortisol
	2D:4D ratio	-0.004	-0.065	-0.074	-0.049	0.101	**0.152***
	Number of risky choices		-0.016	-0.120	0.061	0.085	0.024
	Peers and social support			**0.410**	-0.046	-0.092	-0.107
	School environment				0.053	**-0.187***	-0.096
	Family stress and conflict					0.083	0.074
	Salivary testosterone						**0.498**

* Note:= $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 3
Associations between the six structural equation model and quantitative variables considered in the structural equation metamodel and the dependent variables.

Boys		2D:4D ratio	Number of risky choices	Peers and social support	School environment	Family stress and conflict	Salivary testosterone	Salivary cortisol
	Victim propensity	0.097	-0.004	-0.071	**-0.146** *	-0.085	-0.048	-0.035
	Bully propensity	0.092	-0.058	**-0.174** *	-0.115	-0.043	-0.104	-0.105
	Bully/victim propensity	-0.023	-0.029	**-0.183** *	-0.126	-0.021	-0.065	-0.091
Girls		2D:4D ratio	Number of risky choices	Peers and social support	School environment	Family stress and conflict	Salivary testosterone	Salivary cortisol
	Victim propensity	-0.046	0.037	-0.074	-0.041	**-0.128** *	-0.007	-0.010
	Bully propensity	-0.046	-0.073	0.000	0.039	-0.100	-0.065	-0.067
	Bully/victim propensity	**0.129** *	0.044	**-0.178** *	**-0.205** * *	-0.052	0.050	0.116

Note: *= $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

While in boys, peers and social support was the only predictor associated with bully/victim propensity.

2.4. Structural equation models

We hypothesized that preadolescents' bullying involvement was related to biological factors (2D:4D ratio and prepubertal hormone levels) and their psychosocial context (i.e. decision making, quality of family interactions, peers and social support, school environment). When examining the relationship that hormone levels have with social behaviors, such as aggressive behavior, a number of individual differences may be of particular importance due to their relationship with both hormone levels and behavior. Executive functioning in general and decision making in particular, has shown correlation not only with hormone levels but also with various psychopathological conditions such as aggressive behavior.

With this objective and based on previous literature, we designed the following metamodel (Fig. 1).

The proposed metamodel is very ambitious because it was designed based on several empirical studies that have shown some associations between independent variables and aggressiveness in general, or involvement in bullying in particular. Nonetheless, to our knowledge, no previous study has analyzed the influence of biological and psychosocial factors on the roles that children take in bullying situations.

Structural equation model for victims (Fig. 2)**.** The results of the model testing boys' propensity to be a victim showed a good fit between the model and data (X^2 (5)= 5.018; $p = 0.414$; CFI= 1.00; RMSEA= 0.005; $p = 0.604$). Results indicate that a poor school environment' perception was associated with boys' victimization frequency (b=−0.25; $p = 0.035$), explaining 6.1% of the variance. Moreover, we observed that greater peers and social support was associated with higher levels of cortisol (b=0.18; $p = 0.045$) explaining 3.3% of salivary cortisol variance. Apart from these results, a positive correlation was found between prepubertal testosterone and cortisol ($r = 0.53$; $p = 0.001$).

The model for girls' propensity to be a victim (Fig. 3), showed a good fit between the model and the data (X^2 (3) = 0.997; p-value = 0.802; CFI = 1.00; RMSEA = 0.00; $p = 0.877$). Lower score in family stress and conflict scale, indicating lower quality of family context, was related with being more frequently involved as a victim in girls (b=−0.22; $p = 0.042$), explaining 4.7% of the variance. Moreover, results also suggested that higher salivary testosterone was related with worse perceived school environment (b=-0.19; $p = 0.007$), explaining 3.8% of the variance. Apart from these results, a positive correlation was found between prepubertal testosterone and cortisol ($r = 0.50$; $p = 0.001$).

2.4.1. Structural equation models for bullies

Results of the model testing boys' propensity to be a bully (Fig. 4) showed a good fit between the model and data for the final structural equation model (X^2 (3)= 3.518; $p = 0.318$; CFI= 0.988; RMSEA= 0.035; $p = 0.467$) and support the main idea that propensity to be a bully is associated with some of the studied biological and psychosocial variables. Lower salivary cortisol levels (b=−0.23; $p = 0.051$), worse perceived school environment (b=-0.22; $p = 0.120$), and less peers and social support (b=-0.30; $p = 0.048$) were associated with being more frequently involved as a bully, explaining a large amount of the variance (R^2=25.5). Results also suggest that peers and social support was associated with cortisol levels (b=0.18; $p = 0.045$) explaining 3.3% of the variance. Finally apart from these results, we found a positive correlation prepubertal testosterone and cortisol ($r = 0.53$; $p = 0.001$).

The results of the model testing girls' propensity to be a bully (Fig. 5), showed a good fit between the model and data for the final structural equation model (X^2 (7)= 6.140; $p = 0.499$; CFI= 1; RMSEA = 0.00; $p = 0.744$). Results showed that a worse quality of family interaction was associated with being more frequently involved as a bully (b=−0.22; $p = 0.040$), explaining 4.8% of the variance. Results also suggest 2D:4D ratio was positively related to prepubertal testosterone levels (b=0.15; p = 0.077) explaining 2.3% of the variance and that higher prepubertal testosterone levels were related to worse school environment' perception (b=-0.20; $p = 0.006$), explaining 3.9% of the variance. Apart from these results, a positive correlation was found between prepubertal testosterone and cortisol ($r = 0.51$; $p = 0.001$).

2.4.2. Structural equation models for bully/victims

In the case of the bully/victim role and for both boys and girls, we were unable to fit any valid model (all candidate models presented chi-square test p-value <0.05; CFI values <0.95, and RMSEA p-value

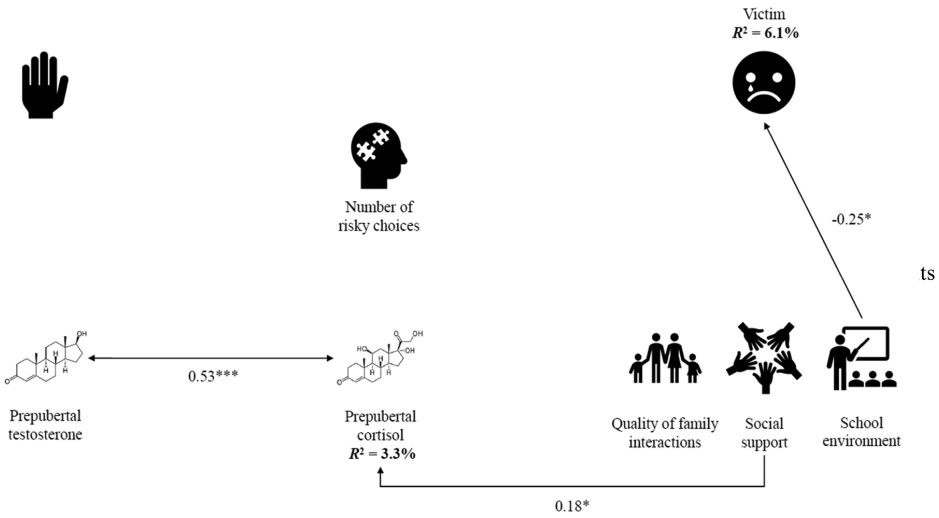

Fig. 2. Final structural equation model for boy's propensity to be a victim. Note: R^2 values indicate the percentage of variance explained. Numbers are the standardized coefficients of the corresponding relationship. *=p < *0.05;* **p < *0.01;* * **p < *0.001*.

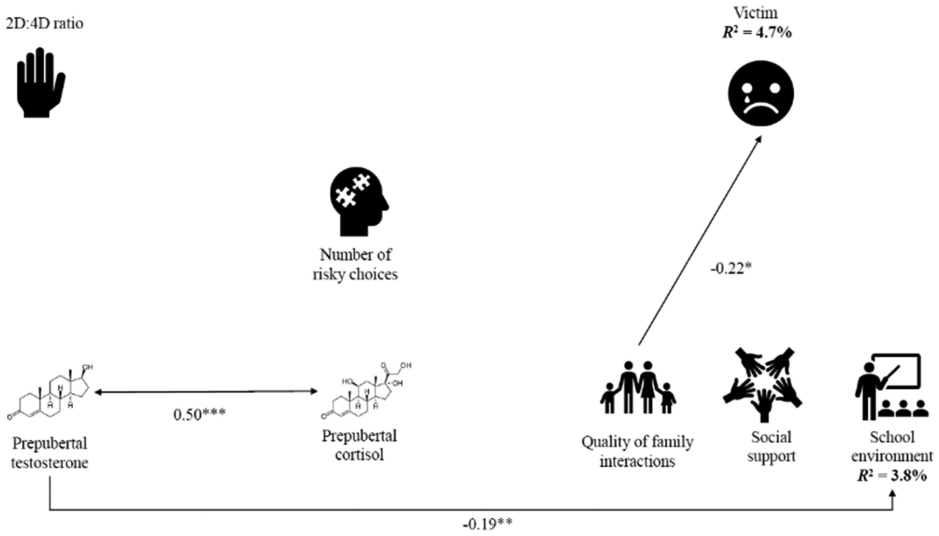

Fig. 3. Final structural equation model for girl's propensity to be a victim. Note: R^2 values indicate the percentage of variance explained. Numbers are the standardized coefficients of the corresponding relationship. *=p < 0.05; **p < 0.01; ***p < 0.001.

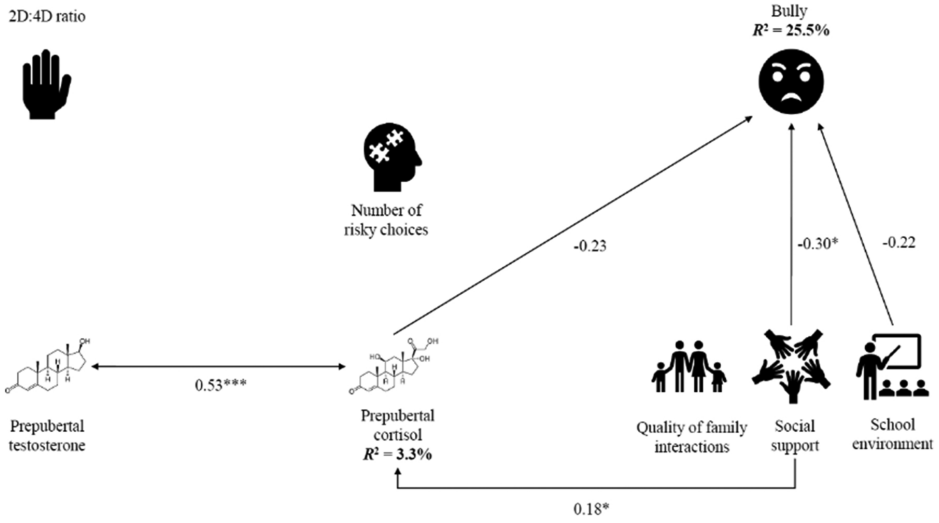

Fig. 4. Final structural equation model for boys' propensity to be a bully. Note: R^2 values indicate the percentage of variance explained. Numbers are the standardized coefficients of the corresponding relationship. * = $p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

<0.05).

3. Discussion

The objective of this work was to study the association that biological and psychosocial factors have with three different roles that preadolescents may take in bullying situations.

First, it should be highlighted that the prevalence of bullying, as well as the preadolescent hormone levels in our sample correspond to values found in other populations of similar ages. Concerning bullying prevalence, our rates are similar to those found in Spanish population in general (García-García et al., 2017) and in population of the Basque Country in particular (Machimbarrena & Garaigordobil, 2018). Likewise, 2D:4D ratio values (Butovskaya et al., 2019; Shaw et al., 2012; Voracek & Offenmüller, 2007) and prepubertal hormone levels in saliva in our study do not differ from those found by other authors (Ostatníková et al., 2002; Pascual-Sagastizabal et al., 2019). Regarding our sample's social characteristics, it is a Spanish sample composed of non-clinical preadolescents and quite homogeneous regarding the sociodemographic factors. As far as school characteristics, half of the sample attended public schools and the other half private schools.

Our main objective was to explore the association that hormone

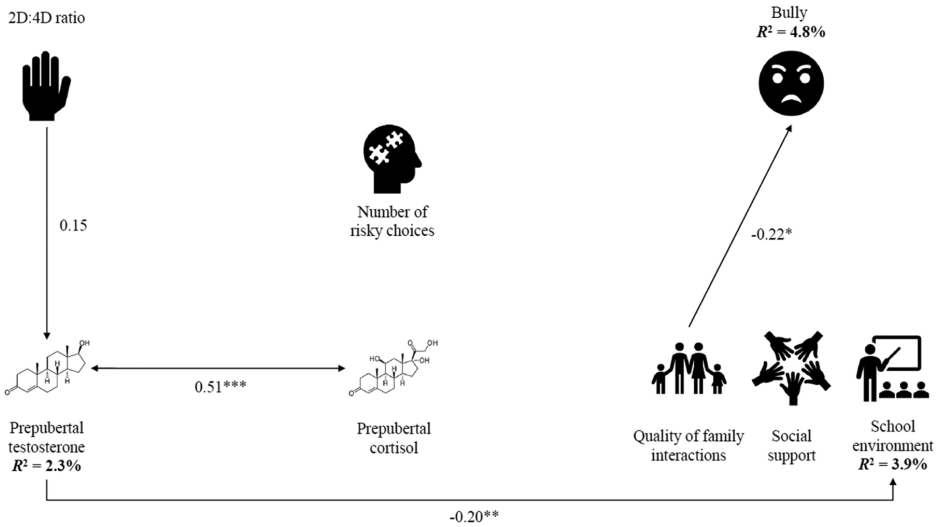

Fig. 5. Final structural equation model for girls' propensity to be a bully. Note: R^2 values indicate the percentage of variance explained. Numbers are the standardized coefficients of the corresponding relationship. *= $p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

levels and psychosocial factors have with bullying involvement. In relation to the victims, in the model for boys, we found that having a poor school environment' perception was related to being victimized more frequently. It can be concluded that the association between school environment and bullying remains stable cross-culturally, as other authors have shown similar results in populations from China (Han et al., 2017), Hong Kong (Chan & Wong, 2015), Thailand (Pengpid & Peltzer, 2013), United States (Gower et al., 2015), United Kingdom (Muijs, 2017), Iceland (Mann et al., 2015), the Netherlands (Jansen et al., 2012) and Colombia (Moratto Vásquez et al., 2017).

Regarding girls, the score on family stress and conflict was consistently related to victimization, showing that those girls with higher family stress and conflict are more frequently victimized. This result goes in line with other authors confirming that having good connectivity and good communication between parents and children are protective factors of victimization (Pengpid & Peltzer, 2013; Shetgiri et al., 2013), whereas family conflict increases the risk of being victimized (Hemphill et al., 2012, 2015). Additionally, Garaigordobil and Machimbarrena (2017) showed in a study carried out in the Basque Country that parents of severe victims, cyber-victims and aggressors had higher stress levels related to their parenting role.

In the case of bullies, in boys, the obtained model supported the main idea that biological and psychosocial factors were related to being more frequently involved as a bully. Lower levels of prepubertal cortisol, worse perceived school environment and less peers and social support were related to being more frequently involved. González-Cabrera et al. (2017) in their study found that cyberbullies showed flattered cortisol secretion curves. In addition, one recent systematic review reached the conclusion that in children and adolescents, bullying was consistently related cortisol (Kliewer et al., 2019), those bullied children showed lower cortisol levels or blunted pattern of cortisol (Östberg et al., 2018; Peters et al., 2011). Regarding psychosocial factors, having a good perceived school environment and higher scores in peers and social support was related to being less frequently involved as a bully. Previous research concluded that having trust in school (Muijs, 2017); good relationships with classmates (Han et al., 2017) and stronger social support (Pengpid & Peltzer, 2013) decreased the risk of being involved in bullying situations.

In the model about girls' propensity to be a bully, higher family stress and conflict was related to being involved as a bully. In this line, one previous study carried out in the Basque Country found that parents of cyber-aggressors showed higher parental stress (Garaigordobil & Machimbarrena, 2017).

Finally, in the case of bully/victim propensity, we did not obtain any valid model. There may be different two possible explanations for this. First, even if we calculated bully/victim involvement based on scores of victim and bully subscale, the OBVQ questionnaire we used does not have a specific subscale to assess this role. Second, the number of participants taking this role in our sample was relatively small, which decreases the probability of detecting the effects, if any, of the studied variables. To the best of our knowledge, few studies analyzed the bully/victim role and therefore, we consider it important to comment on the results obtained in the bivariate analysis. For both sexes, lower score on peers and social support was correlated with being bully/victim involvement. A previous meta-analysis confirm that higher score on social support and good relationship with peers protects against the risk of being involved in bullying situations (Cook et al., 2010). In addition, in girls, the school environment and the 2D:4D ratio were found to be related to this role. Regarding school environment, our results go in line with what other studies found, that is, a worse school environment perception is related to being more frequently involved in bullying situations (Han et al., 2017; Muijs, 2017). In terms of hormone levels, we found that the 2D:4D ratio, i.e. lower prenatal androgens levels, was associated with more frequently involved as bully/victim. To the best of our knowledge there are no previous studies analyzing the association between 2D:4D ratio and bullying. Previous studies analyzed the association between 2D:4D ratio and aggressive behavior, founding a negative association (Burton et al., 2009; Shaw et al., 2012). On the other hand, Vaillancourt, deCatanzaro, Duku, & Muir (2009) in their study found that bullied girl had lower testosterone levels, measured in saliva. Further studies would be necessary to draw conclusions and to understand the mechanisms underlying the relationships between 2D:4D and bullying behavior.

Apart from studying the factors directly associated with bullying, this work aimed to establish possible associations between the different predictor variables. Taking into account boys' models, we observed an interesting positive association between two of the predictor variables: peers and social support and cortisol levels. Previous evidence showed

mixed results concerning the direction of this association, finding one study also a positive association between long-term social support and cortisol measured in saliva. This study concluded that these differences may be explained by the type of social support being assessed, the duration of this social support and the method used to measure cortisol levels (Rosal et al., 2004).

Considering girls' models, we observed a negative association between testosterone and school environment perception. One previous study found that higher testosterone levels were associated with lower sociability in prepubertal boys and girls (Strong & Dabbs, 2000). Additionally, girls with higher testosterone may be exhibiting more typically masculine characteristics and they might be displaced in their peer group and so have more problems at school. This is an interesting result because although testosterone was not directly related to bullying, it showed an association with school environment, which is the context where children and adolescents develop their social relations. Further investigation would be needed to find out the effects that testosterone has in the school environment in general and in bullying in particular.

In addition, taking into account all the models, a positive and statistically significant correlation was found between prepubertal testosterone and cortisol levels. Traditionally, researchers have argued that cortisol and testosterone are mutually inhibitory (Dekkers et al., 2019; Mehta & Josephs, 2010). Interestingly, as our results showed, a study with incarcerated male adolescents found a positive association between testosterone and cortisol (Dismukes et al., 2015). In order to explain this discrepancy, some authors suggested a developmental hypothesis, describing that this positive association may be unique to early stages of puberty when activity in both HPG and HPA axes is growing following childhood (Dahl & Gunnar, 2009; Marceau et al., 2013; Matchock et al., 2007).

We did not find some of the expected associations, we believe that this may be due to the fact that our work is not without limitations. First, the sample size was relatively small considering not only the complexity of the model but also that these were made separated by sex. Second, bullying was assessed using a self-report questionnaire which Basque version was not validated. This scale is composed of two subscales assessing victimization and perpetration specifically, and the bully/victim category was created by the researchers of this work. The reason of assessing this role is that nowadays, bullying is seen as an important role that children can play. The questionnaire allows for differentiation between bullying children and bullying victims, allowing the conclusion to be made that those who have identified themselves in both roles are assigned the role of bullies/victims. Third, most of the measures were transversal and it would be interesting to analyze the association of some longitudinal effects. Despite these limitations, to the best of our knowledge, this is the first study that analyses the association of biological and psychosocial factors with three bullying roles preadolescents may take, analyzing sex differences. This is interesting because although we are not able to directly change the biological factors studied (namely, hormone levels), it would be possible to develop preventive programs that influence the other psychosocial variables that are risk factors themselves but that are related to cortisol levels too. For future research, it would be desirable to continue studying bullying from a bio-psychosocial perspective, analyzing the potential mediation and moderation effects of these independent variables using a larger sample size and study population from other countries.

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CRediT authorship contribution statement

Izaro Babarro: Conceptualization, Investigation, Data collection, Writing – original draft, Supervision. **Ainara Andiarena:** Conceptualization, Investigation, Supervision, Writing – original draft. **Eduardo Fano:** Conceptualization, Investigation, Visualization. **Gonzalo García-Baquero:** Methodology, Data curation, Visualization. **Andrea Lebeña:** Data curation, Visualization. **Enrique B. Arranz-Freijo:** Visualization, Funding acquisition. **Jesus Ibarluzea:** Conceptualization, Writing – review & editing, Project administration, Funding acquisition.

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Hair cortisol as a biomarker of chronic stress in preadolescents: influence of school context and bullying

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ABSTRACT

Bullying has been identified as the most common form of aggression and a major source of stress among children and adolescents. The main objective of this study was to analyze the association that school context in general and bullying in particular might have with hair cortisol concentration (HCC), examining the effect of executive function and sex on this association. The study included 659 11-year -old preadolescents from the cohorts of Gipuzkoa and Sabadell of the INMA (INfancia y Medio Ambiente-Children and Environment) project. We gathered information about school-related factors (bullying, school environment, problems with peers and academic performance) and executive function (risky decision-making). Hair samples were collected to measure cortisol concentrations and Structural Equation Modeling was used to examine associations between school-related factors, executive function and HCC. Results showed that being involved as a bully/victim was related to higher HCC and, higher HCC was associated with poorer executive function. This study may contribute to a better understanding of the consequences that chronic exposure to a stressful factors may have on preadolescents' health and developmental outcomes. Besides, our results are relevant for designing programs for prevention and intervention, which could modify individual physiological responses to stress and reduce the effects of stress on the health.

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Hair cortisol; school context; bullying; executive function; preadolescents

During childhood and adolescence school has been the most studied developmental context. Apart from being a place where children and adolescents develop relationships with peers, it can also be the place where students may experience several stressful demands. Therefore, it is not surprising that school-related stress negatively affects

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students' health (García-Moya et al., 2013). Although acute stress can be beneficial and adaptive, chronic stress can be detrimental to several health outcomes, including the biological systems involved in the stress response. The Hypothalamic–Pituitary–Adrenal (HPA) axis and Sympathetic Adrenal Medullary (SAM) system work together to facilitate adaptation to stress. Specifically, when our bodies identify a stressor, involuntary processes mobilize a rapid SAM response and activation of the HPA axis, leading to cortisol synthesis. This glucocorticoid has been identified as a valuable biomarker of HPA function and it has been studied in relation to multiple indicators of social adversity (Bryson et al., 2021; Lugarinho et al., 2017).

Bullying, defined as a type of aggressive behavior that occurs in the school environment, has been identified as one of the main stress sources among children and adolescents (Vanaelst et al., 2012). The association between bullying and cortisol levels has been explored in some studies, finding mixed results (Kliewer et al., 2019). The inconsistencies in the associations may derive, among others, from the way cortisol levels were measured. Various samples can be used to measure cortisol (blood, urine, saliva, and hair), being saliva and hair samples the most commonly used. With regard to saliva samples, results can also differ based on the amount and timing of samples collected. In order to understand this, it is essential to know that cortisol follows a daily cycle in order to maintain healthy physiological functioning. Specifically, cortisol levels sharply increase in the morning, approximately 30 min after waking up. This is known as the cortisol awakening response (CAR). After this, cortisol levels decline throughout the day, reaching their lowest points after sleep begins. As long as the HPA axis is functioning properly, stress response and cortisol secretion follow predictable patterns; however, this can change under chronic stress conditions.

Regarding the association between cortisol levels and bullying, most research has used saliva samples to determine cortisol levels. Some authors concluded that victims or cybervictims present lower reactivity of cortisol (Calhoun et al., 2014; Knack et al., 2011; Ouellet-Morin et al., 2011, 2013), lower morning cortisol levels (Knack et al., 2011) and flattened cortisol patterns (González-Cabrera et al., 2017; Knack et al., 2011; Peters et al., 2011). However, others have suggested that victimized children have higher cortisol reactivity (Chen et al., 2018; Kliewer, 2006). One recent study which analyzed cortisol in hair samples found that highly victimized boys had higher levels of hair cortisol concentration (HCC) (Ouellet-Morin et al., 2021). With respect to the role of bullies, some researchers suggested that aggressive behaviors in children and adolescents were associated with low HPA axis activity (McBurnett et al., 2000; Platje et al., 2013). In the same vein, González-Cabrera et al. (2017) found that cyberbullies showed flattered cortisol curves. As far as bully/victim roles are concerned, González-Cabrera et al. (2017) found that the HPA axis was over activated in cyberbully/victims. Finally, there are also studies that found no association between victimization and cortisol levels (Vaillancourt & Schmidt, 2011; Williams et al., 2017).

The relationship between bullying and cortisol was found to be sex-dependent by some researchers. According to Vaillancourt et al. (2008) while victimized girls presented lower cortisol levels, victimized boys had higher cortisol levels. Östberg et al. (2018) showed that victims displayed lower cortisol levels and lower CAR. On the contrary, Arbel et al. (2019) found that victimization was related to higher total

cortisol levels. In both studies, however, the associations were only significant among boys.

In addition to bullying, some other school-related factors have been studied in relation to cortisol levels. Flattered cortisol slopes have been described to be related to non-supportive classrooms and conflictive relationships with teachers and peers (Ahnert et al., 2012; Bai et al., 2017). McHale et al. (2012) in their study found that spending more time than usual doing school homework was associated with higher cortisol secretion during the day.

When examining the relationship between social stressors and HPA axis activity, a number of individual differences may be of particular importance due to their association with both, cortisol levels, and social stressors. Among these differences genetic factors, personality traits, or cognitive abilities could be found. Particularly, the effect of stress in executive function has been amply documented. Executive functioning in general, and risky decision-making in particular, has shown correlation not only with hormone levels (e.g., sex hormones or cortisol) but also with various psychopathological conditions, such as aggressive behavior. A meta-analysis showed that despite its impairment on working memory and cognitive flexibility, a main effect of stress on inhibition was not shown. According to this study, stress affects cognitive inhibition, but response inhibition is enhanced (Shields et al., 2016). In the same vein, it has been found that moderate increases in stress levels were related to better executive functioning, however, high increases of cortisol levels were found to cause impaired performance on executive functioning (Pyle Hennessey et al., 2020). Moreover, executive function has also been studied in relation to bullying, concluding that a low executive function was a significant predictor of being involved in bullying behavior, as a victim, as a bully or as a bully/victim (Kloosterman et al., 2014; Verlinden et al., 2014). However, in a previous study an association between executive function and bullying behavior was not found (Babarro et al., 2020). In this line, previous studies have showed that executive functions, peer problems, and bullying experiences also impair childrens academic achievement (Gomes et al., 2020; Pascual et al., 2019). Additionally, sex differences may also impact the association that school-related variables and bullying have with hair cortisol, as well as with individual variables affecting this relationship. Regarding cortisol levels, most of the previous studies concluded that boys had higher HCC than girls (Anand et al., 2020; Gerber et al., 2017; Rippe et al., 2016; Simmons et al., 2016). Although there is also a study who find no difference in HCC by sex (Noppe et al., 2014). Sex differences have also been observed in bullying, generally boys being more involved than girls (Álvarez-García et al., 2015). Moreover, sex differences have been also noted regarding school environment' perception, executive function, and academic achievement. Girls perceived generally the school environment as better than boys (Yates, 2003) and are more likely to succeed at school (Parajuli & Thapa, 2017). Finally, a systematic review concluded that although sex differences exist in brain structures and neural networks underlying executive control functioning, there were mixed results in sex differences in executive function (Gaillard et al., 2021).

As aforementioned, school is the primary context in which children and adolescents are exposed to numerous stressors. In fact, bullying has been identified as the first source of stress during these developmental stages. Previous evidence has shown that various school factors (Ahnert et al., 2012; Bai et al., 2017; McHale et al., 2012) and bullying

(Kliewer et al., 2019) are related to cortisol levels. It has also been noted that when looking at the impact of school factors and bullying on cortisol levels, it important to keep in mind that they are interrelated (Babarro et al., 2020) and that some individual variables could be associated with both stressors and cortisol levels. Among the individual variables, executive function has been linked to cortisol levels (Shields et al., 2016) and bullying (Kloosterman et al., 2014; Verlinden et al., 2014). Sex is another individual variable that has been found to affect cortisol levels (Anand et al., 2020; Grebe et al., 2019), executive function (Gaillard et al., 2021), school related-factors (Yates, 2003) and bullying (Álvarez-García et al., 2015). Therefore, the main objective of this study was to determine whether bullying, along with other school-related factors (problems with peers, school environment, academic performance) could predict chronic stress in 11-year-old preadolescents, examining the effect of executive function and sex on this association. It was hypothesized that school-related factors (problems with peers, poorer school environment, and poorer academic performance) and bullying involvement would predict HPA axis dysregulation. In addition, we expected that higher HCC would predict poorer executive function; and that poorer executive function would be associated with school-related factors (more problems with peers, poorer school environment, and poorer academic performance) and higher bullying involvement.

Methods

Participants

The study participants were preadolescents of the INMA project, from the cohorts of Gipuzkoa (Basque Country, Spain) and Sabadell (Catalonia, Spain). Participants' mothers were recruited in their first trimester of pregnancy in health centers or hospitals of the public health system. Since recruitment, data have been collected in several follow-up phases, and in this study, we used data from the 11-year' follow-up phase, where 871 preadolescents and their families were visited and 212 respondents were excluded due to missing HCC ($n = 164$), or other data ($n = 48$), yielding a final sample of 659. We compared the differences between participants included and excluded from the study (Appendix A) and found that those excluded from the study had more problems with peers, poorer perceptions of the school environment, lower academic scores, and more people involved as victims than those included.

Measures

Hair cortisol

To date, in most studies, serum saliva, or urine samples have been used to analyze HPA axis activity. Blood and saliva samples provide a momentary measure of cortisol concentrations, and lack the ability to retrospectively quantify HPA axis activity during a certain period of time. In order to overcome this problem, hair cortisol analysis was proposed as an alternative. Because hair grows at an average rate of 1 cm per month, hair samples provide a reliable measure of stress system activity retrospectively (Anand et al., 2020).

For this study, trained staff cut hair strands of 3 cm in length from the posterior vertex area of the participants. The hair was enclosed in sealed plastic packages marked with

identification numbers and stored at room temperature until analysis. All analyses were performed in the Clinical Chemistry Laboratory of the University of Linköping (Sweden). Hair samples were first cut into small pieces and were put into a 2 mL QiaGenRB sample tube with a 0.5 mm QuiGen stainless steel bead. The sample tubes were placed into aluminum cylinders and frozen in liquid nitrogen for 2 min and the hair samples were thereafter homogenized for 2 min, producing fine hair powder. 1 mL of the methanol was added to each tube and the samples were extracted overnight on a moving board. Afterward, 0.8 mL of methanol supernatant was pipetted off and lyophilized using a Savant Speed Vac Plus SC210A. The samples were dissolved in radioimmunoassay buffer and analyzed. The primary antibody used was Rabitt Cortisol 3 Polyclonal Antibody (MyBiosource, San Diego, USA). The secondary antibody which was anti-rabbit IgG was Sac Cell AA-Sac 1 (InmmunoDiagnostic System Ltd, Bordon, England). Hair samples between 3 and 10 mg were required to maintain a total inter-assay coefficient of variation below 8% for hair extraction and measurement of cortisol by the radioimuunoasay.

Bullying: Olweus Bully Victim Questionnaire (OBVQ)

This version consist of a standard definition of bullying and 16 questions (e.g., "I was called mean names, was made fun of, or teased in a hurtful way") about bullying experiences in the past 2 months. The first eight items refer to different victimization behaviors (physical, verbal, social, sexual, and cyberbullying) and, the following eight to physical, verbal, social, sexual, or cyber harassment to another student. Items are rated on a 5-point Likert scale (0 "it has not happened to me in the past couple of months," 1 "it happens once or a few times," 2 "it happens 2 or 3 times a month (every month)," 3 "it happens "every week" and 4 "it happens several times a week"). A dichotomized variable was created following criteria of Solberg and Olweus (2003): (0) not involved or (1) frequently involved in bullying. So, for this study we used three variables of two categories, one for each role participant could take in bullying situations: victim (not involved (0) or frequently involved as a victim (1)), bully (not involved (0), or frequently involved as a bully (1)). The OBVQ showed adequate internal consistency in the present sample: $\alpha = 0.82$ for victim scale and $\alpha = 0.67$ for bully scale.

School environment: Kidscreen-27 questionnaire (Kidscreen-27, n.d.)

This self-reported questionnaire consisted of 27 items based on the previous week that are rated on a 5-point Likert scale (1 "never," 2 "seldom," "quite often," 4 "very often" and 5 "always"-reflecting the frequency of behaviors or feelings and 1 "not at all," 2 "slightly," 3 "moderately," 4 "very," and 5 "extremely"-reflecting the intensity of a belief or attitude). The items were divided into five dimensions: Physical well-being, Psychological well-being, Peers and social support, Parents and autonomy, and School environment. In all cases, a higher score was indicative of higher quality of the measured construct. For this study, we used only the subscale of school environment (e.g., "Have you enjoyed going to school?"). The questionnaire showed acceptable internal consistency in the present sample for each of the subscales, being $\alpha = 0.70$ for school environment.

Problems with peers: Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997)

Parents were asked to complete the questionnaire to assess the general behavioral development of their children. The SDQ comprises 25 items in total, divided into 5 separate subscales: emotional symptoms, conduct problems, hyperactivity-inattention, peer relationship problems, and prosocial behavior. The items are rated on a 3-point Likert scale (0 "not true," 1 "somewhat true," and 2 "certainly true"). In this study, the subscale about peer relationship problems was used (e.g., "Generally liked by other children"). The internal consistency for the questionnaire was acceptable in the present sample ($\alpha = 0.78$).

Risky decision making. Cups Task Roulette Version Test (Levin et al., 2007)

2007This computer task, consisted of 54 trials that assessed risky decision-making. More specifically, this task assesses hot executive function (cognition influenced by emotion), analyzing whether the participant adjusts is risky behavior according to the probabilities and importance of the outcome. In this task, the participants were presented with two wheels divided into segments of equal size and each associated with an amount of money. On each trial, the participants were asked to choose which wheel to spin, to gain, or avoid losing money. After the response, the wheel selected spun for 2 s and then ended on the amount of money to be won or lost. For this study, we took into account the total number of risky decisions each child made.

Academic achievement: ad hoc questionnaire

Only for children from Gipuzkoa cohort, we assessed their academic achievement skills using an *ad hoc* questionnaire. Using a 6-point Likert scale (1 "much less than his/her peers," 2 "less than his/her peers," 3 "slightly less than the average of his/her peers," 4 "slightly higher than the average of his/her peers," 5 "higher than his/her peers," and 6 "much higher than his/her peers") the students' tutor should evaluate each preadolescent regarding their ability in reading, attention, mathematics, Spanish and Basque. For this study, we created a punctuation for academic achievement based on the average each preadolescent achieved in all the areas. The higher the score, the better was the students academic achievement.

Data analysis

SPSS 27 and AMOS 23 (IBM, Armonk, NY, USA) were used to conduct data analysis. First, wee carried out the descriptive analysis and explore the differences by cohort and sex. Besides, we carried out bivariate analysis after making descriptive analysis. Then, we conduct Structural Equation Modeling (SEM). SEM makes the assumptions of linearity in the relationships between continuous variables and Gaussian error terms, in the first step we studied the symmetry of each relevant variable, transforming data, when appropriate. We also analyzed the linearity using GAM plots and we found that associations between the variables were linear.

After constructing the metamodel (Figure 1) based on *a priori* theoretical knowledge and after exploratory data analysis to ensure that SEM assumptions were met, we obtained global estimates. Data to model consistency was evaluated using a chi-square

test comparing the tested model with a saturated model. Apart from the aforementioned chi-square test, the root mean square error of approximation (RMSEA) was used. The final models were accepted only when the following conditions were met: chi-square test p-value > .05, the CFI > 0.95, and RMSEA p-value < .05.

Multigroup analysis was used to check if the proposed relationship among the variables would vary across different conditions in some variables: sex and cohort. The effect of the cohort was assessed by the study design. Sex was tested for the influence they could have on both the variables identified as stressors, cortisol levels, and executive function.

In addition, a sensitivity analysis was conducted incorporating to the models the data about academic achievement that was only available for the Gipuzkoa sample.

Metamodel

The purpose of the study was to explore if preadolescents' HCC was determined not only by bullying implication but also by other school-related variables. We also aimed to study the role of risk seeking and sex for its relation not only with bullying behavior but also with cortisol levels. With this objective and based on previous literature, we designed a metamodel (Figure 1).

Previous evidence showed that school-related factors (Ahnert et al., 2012; Bai et al., 2017; McHale et al., 2012) and bullying can affect cortisol levels. School-related factors such as peer relationships or school environments may also contribute to bullying (Babarro et al., 2020). Therefore, we incorporated these associations into our model. In addition, some individual variables may also be of interest when studying the

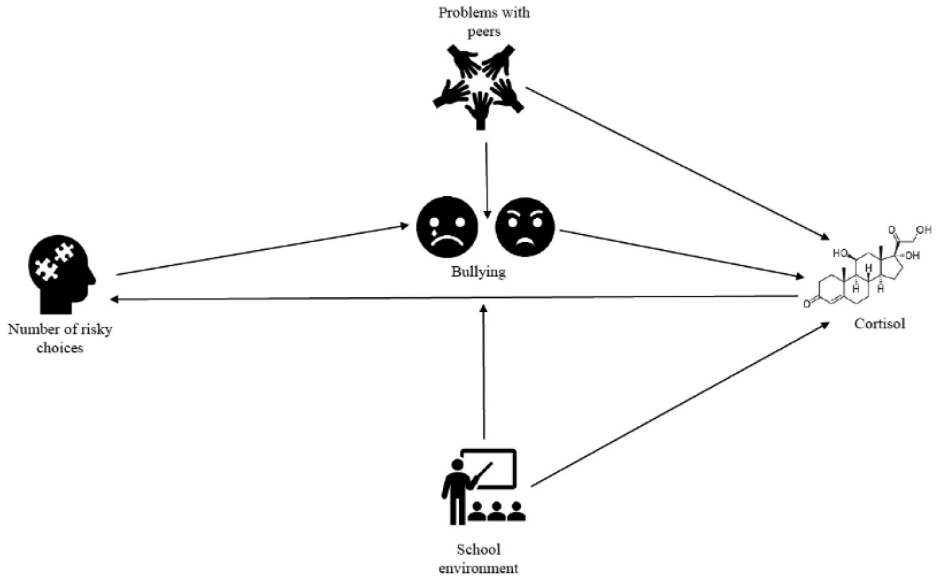

Figure 1. Metamodel summarizing the hypothesized relationships among <bullying involvement> (victim role, bully role, bully/victim role), <school variable> (school environment measured with *KidScreen 27*, peer problems with *SDQ*) and <individual variables> (number of risky decisions assessed with *Cups Task*), whose hypothesized direct and indirect effect on hair cortisol levels.

relationships between stress factors and cortisol levels. These include executive function and sex. Executive function has been examined in relation to cortisol levels (Shields et al., 2016) and bullying (Kloosterman et al., 2014; Verlinden et al., 2014). Furthermore, sex has been found to be related to cortisol levels (Anand et al., 2020; Grebe et al., 2019), executive function (Gaillard et al., 2021), bullying (Álvarez-García et al., 2015) and other school-related factors (Yates, 2003). All of these previous evidences are incorporated into the present complex model.

Multigroup analysis was used to test whether the proposed model differed by sex and cohort. After testing multigroup analysis we concluded that there were no effect of cohort or sex, so we decided to test the models in the total sample.

Results

Sample description

The study sample consisted of 659 children (58.7% girls and 41.3% boys) of 11 years ($M = 10.95$; $SD = 0.46$) from the Gipuzkoa ($n = 335$) and Sabadell ($n = 324$) cohorts of the INMA project. The mean HCC was 10.69 pg/mg ($SD = 11.71$). Regarding prevalence of bullying, 8% were considered victims of bullying, 1.7% were bullies and another 1.7% were classified as bully/victims.

An initial analysis was conducted to assess differences between the cohorts. The only statistically significant differences were children' age and risky decisions score. Specifically, participants from Sabadell were older, attended more to public school and made less risky choices, what means that they had better executive function.

Sex differences

Our results did not show statistically significant differences by sex in hair cortisol. Regarding predictor variables, differences were observed in executive function, school perception, and academic achievement. On average, boys made more risky decisions what means, poorer executive function. They also have more problems with peers, worse perceptions of the school environment and were more involved in bullying as a bully/victim (Table 1).

Table 1. Differences in the variables by sex.

Variable		Female	Male	Statistic
Cortisol (pg/mg)		2.20 (0.47)	2.23 (0.44)	t (657) = −1.014; p = 311
Number of risky decisions (Cups Task)		**29.57 (9.72)**	**31.75 (8.01)**	***t* (640.41) = −3.141; *p* = .002**
Problems with peers (SDQ)		0.67 (0.74)	0.78 (0.77)	t (657) = −1.89; p = .059
School environment (Kidscreen-27)		**1.68 (0.40)**	**1.58 (0.43)**	***t* (657) = 3.091; *p* = .002**
Academic skills		**4.38 (0.86)**	**4.17 (0.89)**	***t (333)* = 2.221; *p* = .028**
Victim total (OBVQ)	Not involved	356 (58.7)	250 (41.3)	*Chi* (1) = 0.001; p = .971
	Frequent	31 (58.5)	22 (41.5)	
Bully total (OBVQ)	Not involved	378 (58.4)	269 (41.6)	*Chi* (2) = 0.913; p = .339
	Frequent	8 (72.7)	3 (27.3)	
Bully_victim total (OBVQ)	**Not involved**	**383 (59.2)**	**264 (40.8)**	***Chi* (2) = 4.546; *p* = .033**
	Frequent	**3 (27.3)**	**8 (72.7)**	

M = mean; *SD* = Standard Deviation; F = frequency.

Table 2. Bivariate associations between predictor variables and hair cortisol concentrations.

Variable		M (SD)	Statistic
Cohort	Gipuzkoa	2.24 (0.48)	t (657) = 1.42; p = .156
	Sabadell	2.19 (0.43)	
Age		10.95 (0.46)	r = −0.032; p = .41
Sex	Girl	2.20 (0.47)	t (657) = −1.01; p = .311
	Boy	2.23 (0.44)	
Problems with peers (SDQ)			r = 0.003; p = .941
School environment (Kidscreen-27)			r = −0.036; p =.362
Number of risky decisions (Cups Task)			**r = 0.112; p = .004**
Academic skills		4.29 (0.88)	r = −0.047; p = .393
Victim (OBVQ)	Not involved	2.21 (0.45)	
	Victim	2.20 (0.52)	t (657) = 0.145; p = 0.885
Bully (OBVQ)	Not involved	2.21 (0.45)	
	Bully	2.15 (0.58)	t (656) = 0.420; p = .675
Bully/victim (OBVQ)	**Not involved**	**2.21 (0.46)**	
	Bully/Victim	**2.48 (0.42)**	**t (656) = −1.970; p = .049**

M = mean; *SD* = Standard Deviation; F = frequency.

Bivariate findings

The examination of bivariate relationships showed that two of the variables included in the model was positively associated with HCC: the number of risky decisions (measured with Cups Task) and preadolescents' involvement as a bully/victim. On the one hand, a higher number of risky decisions, which means poorer executive function was related to higher HCC. On the other hand, those preadolescents involved in bullying as a bully/victim showed higher HCC (Table 2).

Structural equation model for victims

The results of the model testing the way HCC changes depending on involvement in bullying as a victim and other individual and school-related factors are shown in Figure 2. The final structural equation model showed a good fit between the model and data ($\times^2$ (3) = 5.876; p = .118; CFI = 0.912; RMSEA = 0.038; p = .596). Results indicated that only one of the studied variables was associated with HCC, specifically, higher HCC was associated with taking more risky decisions, which means poorer executive function (b = 0.113; p = .004). Besides, in this model, we observed associations between some predictor variables: having problems with peers (b = 0.130; p = .001) was related to being more involved as a victim, while perceiving a good environment was related negatively to be a victim (b=-0.132; p = .001).

Structural equation model for bullies

The results of the model testing the way in which HCC changes depending on preadolescents' involvement in bullying as a bully and other individual factors related to school are shown in Figure 3. The final structural equation model showed a good fit between the model and data ($\times^2$(1) = 1.151; p = .283; CFI = 0.900; RMSEA = 0.015; p = .592. Results indicate that only one of the studied associations was statistically significant, higher HCC were related to a higher number of risky choices (b=0.112; p = .004).

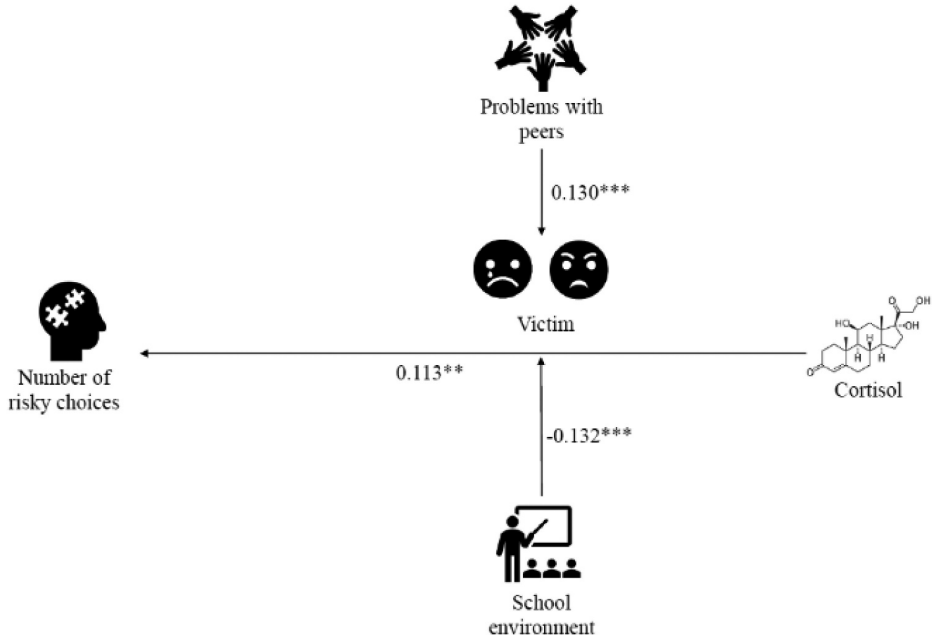

Figure 2. Final structural equation model taking into account victim role. Numbers are the standardized coefficients of the corresponding relationship. *=$p < .05$; **$p < .01$; ***$p < .001$¸•$p < .10$.

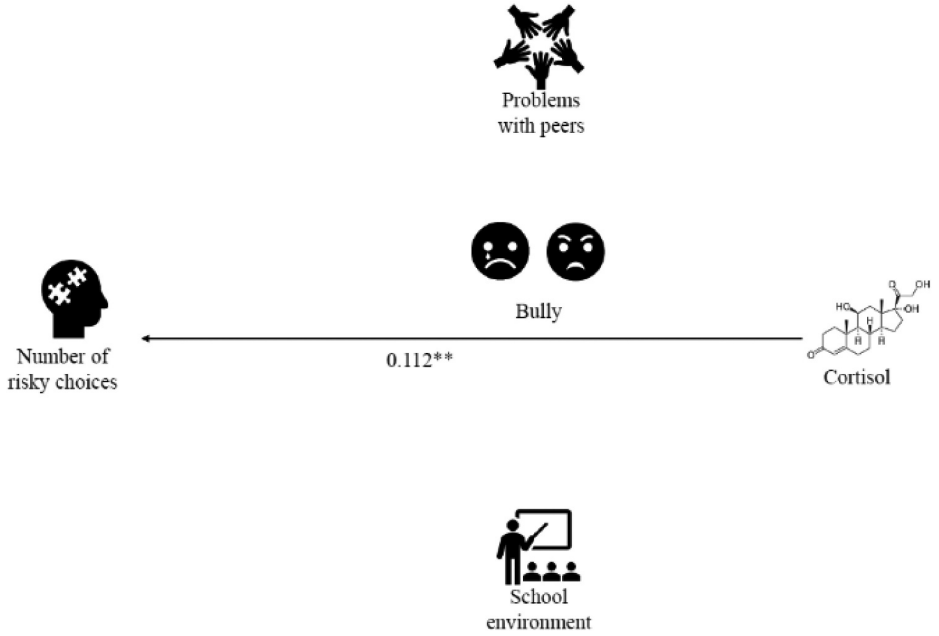

Figure 3. Final structural equation model taking into account bully role. Numbers are the standardized coefficients of the corresponding relationship. *=$p < .05$; **$p < .01$; ***$p < .001$¸•$p < .10$.

Structural equation model for bully/victim

The results of a model that test how HCC is affected by your involvement in bullying as a bully/victim and other school-related factors are shown in Figure 4. The final structural equation model showed a good fit between the model and data ($\times^2(1) = 1.153$; $p = .283$; CFI = 0.978; RMSEA = 0.015; $p = .592$). Results indicate that only one of the studied variables seems to be related to hair cortisol levels, showing a marginally significant association. Particularly, being more involved as a bully/victim was associated with higher hair cortisol levels ($b = 0.075$; $p = .056$). Moreover, we observe that higher cortisol levels were related to a higher number of risky choices ($b = 0.112$; $p = .004$), which means that having higher cortisol levels was associated with lower inhibitory control. Lastly, we found that reporting a worse school environment showed a marginally significant association with being involved in bullying as a bully/victim (b=-0.068; $p = .079$).

Sensitivity analysis

In order to analyze the effect of academic achievement, a a sensitivity analyses was conducted, only for participants from Gipuzkoa. The results of the model testing the way HCC changes in response of involvement in bullying as a victim and other individual and school-related factors showed good fit between the model and the data ($\times^2$ (2) = 5.991; $p = .200$; CFI = 0.916; RMSEA = 0.039; $p = .543$). The results showed that HCC was related to making more risky decisions, what means having poorer executive function (b = 0.105; $p = .056$). A worse a perception of school environment (b = -0.108; $p = .045$) and having more problems with peers ($b = 0.119$; $p = .028$) were related to being a victim.

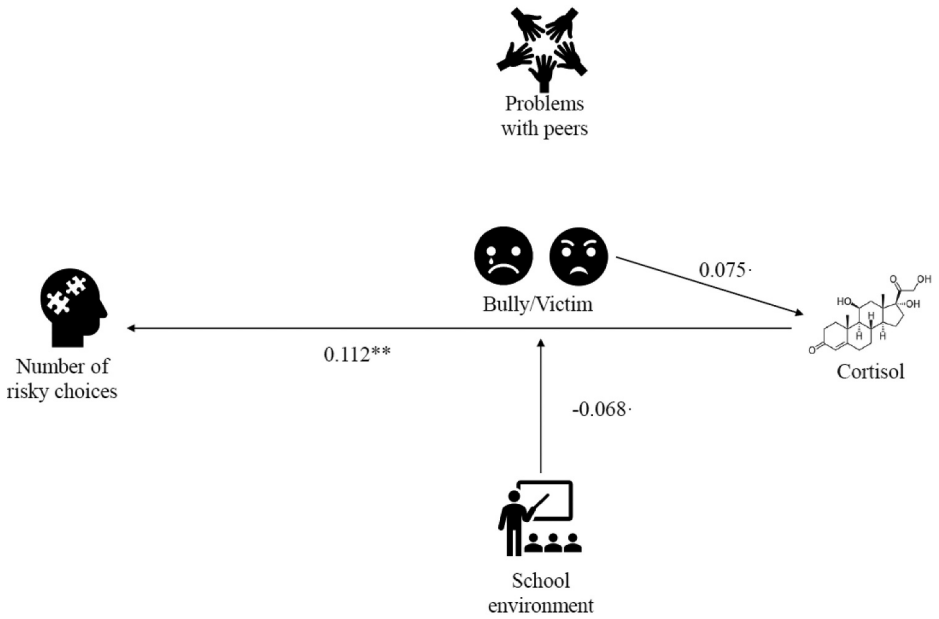

Figure 4. Final structural equation model taking into account bully/victim role. Numbers are the standardized coefficients of the corresponding relationship. *=$p < .05$; **$p < .01$; ***$p < .001$¸·$p < .10$.

Apart from these associations, this model showed that being involved as a victim (b = -0.148; p = .006) and having peer problems (b = -0.121; p = .024) was related to having lower academic achievement. Moreover, taking more risky decisions, that is, having poorer executive function, was related to having poorer academic achievement (b = -0.093; p = .082). Finally, the models for bullies and for bully/victims did not fit the data.

Discussion

The main objective of this work was to study the influence that school environment in general and bullying, in particular, have on HCC, examining the effect of executive function and sex. Regarding the association of the school-related stressors and HCC, we only found a trend-level association: being involved as a bully/victim was positively related to higher HCC. To the best of our knowledge, this is the first study analyzing the association of different roles that children may take in bullying with HCC. As far as we know only two previous study has examined the association between bullying and cortisol levels measured hair samples. One study found that although cumulative psychosocial adversities were associated with cortisol levels, peer victimization was not statistically significant (Ouellet-Morin et al., 2021). Other study concluded that HCC interacted with sex, finding that boys exposed to high victimization had higher HCC (Ouellet-Morin et al., 2021). However, the vast majority of studies investigating bullying and cortisol levels have used saliva samples and produced inconsistent results. Our results goes in line of what González-Cabrera et al. (2017) found in their study that HPA axis was over activated in cyberbully/victims. The heterogeneity of results in the studies examining the association between bullying and cortisol may be due to measurement of cortisol and bullying, research design, or sampling. But the physiology of the stress response may also explain differences in cortisol levels. According to previous research, stressors can induce a hyper- or hypo-response to the HPA axis. Different environments and experiences may not trigger the same response because they are not equally threatening. In response to recent or short-term stressors, the physiological stress response is often hyperactive; however, as time passes and the stressor becomes chronic and when this is temporary distant or is no longer present, the cortisol levels tend to lower (Liu & Doan, 2019; Miller et al., 2007). These findings are consistent with the hypothesis that when chronic stress first begins there is an activation of the axis, which result in elevated concentrations of cortisol and as time passes the activity diminished and cortisol levels are below normal. This hypothesis can explain the association found in the present study. We observed a positive correlation between bullying/victimization and having higher levels of HCC. This could be due to the fact that the time when the source of stress, i.e., bullying, is relatively close to the date when the hair was collected or even still present.

On the other hand, none of the other studied school-related variables, such as problems with peers, school environment perception, or academic achievement were related to HCC. Previous literature found that, students in non-supportive classes and with conflictive relationships with teachers and peers showed a flattered response of cortisol (Ahnert et al., 2012; Bai et al., 2017), whereas spending more

time than usual doing school homework was linked to more cortisol secretion on the day (McHale et al., 2012). However, a recent review concluded that the published research provided inconsistent and limited evidence of the association between social adversity and hair cortisol in children (Bryson et al., 2021).

We also studied the effect that risk seeking as indicator of executive function could have due to its relationship with the stressors and also with cortisol levels. We found a statistically significant association between high HCC and a greater number of risky decisions, and therefore, with poorer executive function. Although acute stress has a significant impact on executive functions, the role that chronic stress has on executive functions is not well understood. As far as we are aware, only three studies have examined the association between HCC and executive functions, and of those, only one previous study analyzed this association in children which found that a negative relationship between HCC and working memory even though it was not statistically significant (Pyle Hennessey et al., 2020).

Finally, the sensitivity analysis showed that, when added information about academic achievement, we only obtained a valid model for victims. Although all the previous associations were still present, no association was observed between academic achievement and HCC. Previous literature showed that even if academic problems were related to having higher cortisol wake-up responses, there was no association between academic problems and the diurnal cortisol profile (Bai et al., 2017). Additionally, in this model we observed that having poorer executive functions, having more peer problems and being involved as a victim was related to having worse academic achievement. Our results are in line with previous studies which have shown that executive functions, peer problems and bullying experiences are associated with school-related difficulties, such as academic achievement or school attendance (Gomes et al., 2020; Pascual et al., 2019).

This study is not, however, without limitations. First, this study has a cross-sectional design. Second, Bullying was assessed using only a self-report questionnaire. The use of peer nominations or a teacher questionnaire may be considered for future studies. Additionally, the scale we used to assess bullying is composed of two subscales assessing victimization and perpetration specifically, and the bully/victim category was created by the researchers of this work. Third, we did not take into account other possible confounding school-related factors, such as relationships with teachers or time preadolescents spent doing their homework, and we neither assessed perceived stress or other social factors that could be having influence on HCC out of the school context. Finally, it is also possible that the sample is a limitation. Some participants in our study were excluded because they did not have information about the variables of interest, as we explained earlier. When comparing the differences in the study variables between participants included and not included, we found that those who were excluded experienced more peer difficulties, the school environment was perceived as less friendly, academic scores were lower, and more people experienced bullying. These differences may be showing that perhaps the participants included in our study (those who had complete information) score better on the variables related to the school context and bullying and therefore we may be missing the effect of these variables on stress levels.

Implications and contributions

Our study allows to gain a deeper understanding of the relationship between school stressors and neurophysiological function. Besides, this study offers results that may be relevant for designing programs for prevention and intervention. These could modify individual physiological responses to stress and reduce the effects of stress on the health.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix A. Differences in the variables between included and non-included participants

Table A1. Differences in the variables between included and non-included participants.

Variable		Included	Non-included	Statistic
Cortisol (pg/mg)		2.21 (0.46)	2.22 (0.42)	t (697) = 0.112; p = .911
Number of risky decisions (Cups Task)		30.47 (9.11)	30.61 (9.55)	t (853) = −0.180; p = .857
Problems with peers (SDQ)		**0.72 (0.75)**	**0.94 (0.79)**	**t (859) = −3.515; p = .000**
School environment (Kidscreen-27)		**1.64 (0.42)**	**1.54 (0.41)**	**t (843) = −2.834; p = .005**
Academic achievement		**4.29 (0.88)**	**3.96 (1.02)**	**t (376) = 2.277; p = .023**
Victim total (OBVQ)	**Not involved**	**604 (91.9)**	**171 (86.4)**	***Chi* (1) = 5.56; p = .018**
	Frequent	**53 (8.1)**	**27 (13.6)**	
Bully total (OBVQ)	Not involved	646 (91.9)	197 (99.0)	*Chi* (2) = 0.457; p = .499
	Frequent	53 (8.1)	2 (1)	
Bully_victim total (OBVQ)	Not involved	644 (98.3)	264 (40.8)	*Chi* (2) = 0.021; p = .886
	Frequent	11 (1.7)	3 (1.5)	

M = mean; *SD* = Standard Deviation; F = frequency.

8.2. Argitaratutako Beste Lanak

Babarro, I., Andiarena, A., Fano, E., Lertxundi, N., Ibarluzea, J. (2022). 2D:4D indizearen zeharkako neurketa: software bidezko irudien analisiaren behatzaile arteko / barneko fidagarritasuna. *Ekaia zientzia eta teknologia aldizkaria, ahead of print,* https://doi.org/10.1387/ekaia.22912

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9. Kongresuetan Aurkeztutako Lanak

XL Reunión anual SEE. Donostia-San Sebastian (Spain). 31/08/2022-02/09/2022.

- Oral communication: Cortisol en pelo como biomarcador de estrés crónico: influencia del contexto escolar y el bullying.
- Oral communication: Validación de un cuestionario auto-reportado de actividad física mediante acelerometría en niños/as europeos/as de 6 a 12 años.

34th Annual Conference of the International Society for Environmental Epidemiology. Athens (Greece). 18/09/2022-21/09/2022.

- Poster: Hair cortisol as a biomarker of chronic stress: influence of school context and bullying.

XXXIX Reunión anual SEE. Leon (Spain). 07/09/2021-10/09/2021

- Oral communication: Explican las variables biológicas y psicosociales la victimización por bullying en preadolescentes?
- Oral communication: Prenatal smoke exposure and anogenital distance at 4 years in the INMA-Asturias cohort.

VI Congreso Internacional de Contextos Psicológicos, Educativos y de la Salud. Madrid (Spain). 25/11/2020-17/11/2020

- Oral communication: Do prenatal and pubertal hormones mediate the effect of the psychosocial context on school bullying victimization?
- Poster: Reliability of the 2D:4D index determination using a computer software.

I Congreso Virtual de La Sociedad Española de Epidemiología. Bilbao (Online). 21/10/2020-30/10/2020

- Oral communication: Estudio Epidemiológico Previo a la puesta en marcha de la planta de valorizaciones.
- Oral communication: Explicando la aceptación de la planta de valorización energética de zubieta a través de variables sociodemográficas y psicoambientales.
- Oral communication: Factores de riesgo y factores protectores del bullying en un estudio de cohortes en España.

5th International congress of clinical and health psychology on children and adolescents. Oviedo (España). 14/11/2019-16/11/2019

- Oral communication: Factores individuales y familiares asociados al bullying en la cohorte de INMA-Gipuzkoa

Congreso SESA. Valencia (Spain). 22/05/2019-24/05/2019

- Oral communication: Efectos de la exposición al humo del tabaco e indicadores socioeconómicos en problemas de conducta durante la infancia. Proyecto INMA.

10. Estantzia Linköping Unibertsitatean

Zentrua: Linköping Unibertsitatea

Departamentua: Zientzia kliniko eta biomedikoen departamentua.

Ikertzaile nagusia: Gudjon Elvar Theodorsson

Hiria: Linköping (Suedia)

Data: 14/04/2021-15/07/2021

11. Bestelako Eranskinak

11.1 2D:4D Indizearen Determinazioa

Materiala

- Ordenagailua
- Eskanerra
- Toaila beltz bat
- Identifikazio zenbakia (ID) duen paper zati bat

Prozedura

1. Haur edo aurrenerabearen eskuan eskuetako lerro falangikoa tapatzen objekturik ez dagoela (adb:eraztunak) eta eskuak garbi dituela konprobatu.
2. Eskanerraren beiran partaidearen ID zenbakia duen paper zatia kokatu, hatzen neurketa oztopatuko ez duen toki batean.
3. Haurrari eskua beira gainean kokatzeko eskatu.
4. Eskuaren gainean toaila beltz bat kokatu, irudiak kalitate handiagoa izan dezan.
5. Irudia ID zenbakiaz identifikatu eta prozedura erregistratu.
6. Prozedura erregistratu beste eskuarekin.

11.2. EKAIA Artikulua: "*2D:4D Indizearen Zeharkako Neurketa: Software Bidezko Irudien Analisiaren Behatzaile Arteko/Barneko Fidagarritasuna.*"

Babarro, I., Andiarena, A., Fano, E., Lertxundi, N., Ibarluzea, J. 2D:4D indizearen zeharkako neurketa: software bidezko irudien analisiaren behatzaile arteko/barneko fidagarritasuna. Ekaia, *in press.* https://doi.org/10.1387/ekaia.22912

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Behin-behineko bertsioa (euskara-orrazketaren faltan).

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2D:4D indizearen zeharkako neurketa: software bidezko irudien analisiaren behatzaile arteko/barneko fidagarritasuna

(Indirect measurement of 2D:4D ratio: Inter/ intra observer reliability of image analysis by software)

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Laburpena: *Sexu hormonek eragina dute garunaren garapenean, egituratan eta funtzionamenduan, eta, ondorioz, gizakion jokaeran. Haurdunaldiko hormona esposizio mailen adierazle bat da 2D:4D indizea. Indize honen fidagarritasunaren inguruko ikerketek erakutsi dutenez, 2D:4D indizea neurtzeko ordenagailuko irudien analisirako programak erabiltzea metodo fidagarria da. Hau horrela izanik ere, ez dago adostasunik zein programa erabiltzearen inguruan. Lan honen helburuak bi dira: 2D:4D ratioa neurtzeko erabili diren bi softwareen fidagarritasuna aztertzea (behatzaile-barneko eta behatzaile-arteko fidagarritasunari erreparatuz) eta neurketen ekonomia ezagutzea. Horretarako, 11 urteko 180 parte-hartzaileen eskuetako eskanerrak jaso ziren. Neurketak irudien analisirako ordenagailuko bi programa erabiliz neurtu ziren (GIMP eta AutoMetrik). Emaitzek erakutsi dute, nahiz eta AutoMetrik programa bizkorragoa izan, GIMP programak behatzaile-barneko eta behatzaile-arteko fidagarritasun altuagoa erakusten duela. Ondorio bezala esan daiteke, 2D:4D indizearen neurketak egiteko irudien analisia erabiltzen duten metodoen desberdintasunak ikertzen dituzten lan gutxi daudenez, ikerketa gehiago egin beharko liratekeela gai honen inguruan.*
Hitz gakoak: 2D:4D indizea, neurketa, fidagarritasuna, softwarea, sexua, haurrak.

Abstract: *Sex hormones have effect on brain structures and so, on human behaviors. A non-invasive indicator of prenatal sex hormone exposure is the 2D:4D index. Previous literature on its reliability indicated that software analysis method is a reliable one, but, still, there is no consensus in which program should be used. The objectives of the present study are, to analyze the intraobserver and interobserver reliability of two softwares used to measure the 2D:4D ratio, and to explore the measurements´economy. Scans of hands of 180 11 years-old participants´ were collected, and measurements were done using GIMP and AutoMetric programs. Results showed that although AutoMetric is a faster program, GIMP presented higher intra and interobserver reliability. To sum up, further research should be carried out on this subject, because of the few studies analyzing differences in image analysis methods.*
Keywords: 2D:4D ratio, measurement, reliability, software, sex, children.

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1. SARRERA

Aurrerapen teknologikoek, prozesu biologikoek eta biokimikoek portaeran izan ditzaketen efektuen azterketa ahalbidetu dute [1]. Hormonek, eragina dute nerbio-sistemaren garapenean, garuneko funtzionamenduan eraginez. Hortaz, efektua izan dezakete garuneko egitura horietan oinarritzen diren funtzio kognitibo eta jokabideetan [2,3].

Phoenix, Goy, Gerall, eta Young (1959), lehenak izan ziren proposatzen animalia eredu bat erabiliaz, sexu- hormonekiko jaio aurreko esposizioak haurren nerbio-sistemaren garapenean eta, helduaroko portaeretan efektuak izan zitzakeela [4]. Ikerketa hau abiapuntutzat hartuz, hainbat autorek aztertu du jaio aurreko sexu-hormonek, batik bat, testosteronak eta estradiolak, gizon eta emakumeen garunean duten papera. Lau urteko haurrekin egindako ikerketa batean, esaterako, Finegan Niccolsek eta Sitareniosek (1992), jaio aurreko testosterona mailek, haurren hizkuntzaren ulermena eta taldekatze kontzeptuarekin alderantzizko harremana erakusten zutela, aurkitu zuten. Harreman hau nesketan soilik izan zen estatistikoki esanguratsua [5]. Bere aldetik, Grimshau, Sitarenios eta Fineganek (1995), likido amniotikoan testosterona kontzentrazio handiagoak zituzten neskek, 7 urtetan garapen kognitibo hobea zutela aurkitu zuten. Beste lan batzuk ere erakutsi dute, jaio aurreko testosterona mailak haurraren garapenean adin eta arlo desberdinetan eragina izan dezakeela, hala nola, soziabilitatean (12 hilabetetan), lexikoan (18 eta 24 hilabetetan) edota harremanen kalitatean (48 hilabetetan) [6,7].

Nahiz eta jaio aurreko sexu-hormona mailak ezagutzea erabilgarria den, hormona mailak zuzenean neurtzeak, metodo konplexuak, inbaditzaileak eta muga etikoak dituzten erabiltzea suposatzen du [8,9]. Hori dela eta, jaio aurreko sexu-hormona mailak ezagutzeko

biomarkatzaile ez-inbaditzaile, ekonomiko eta eskuragarri baten erabilera proposatu zen: 2D:4D indizea [10].

2D:4D indizea bigarren eta laugarren hatzetako luzera neurtzean oinarritzen da, zehazki bigarren hatzaren luzera balioa laugarren hatzaren luzeraren balioagatik zatituz [11–13]. 2D:4D indizearen eta jaio aurreko hormonen arteko loturari dagokionez, ikertzaileek ondorioztatu dute, indize baxuak, jaio aurreko testosterona maila altuekin eta estradiol maila baxuekin erlazionatzen direla [14,15]. Zenbait ikerketek erakutsi du, 2D:4D indizean estatistikoki esanguratsuak diren desberdintasunak daudela sexuaren arabera, indize baxuak gizonezkoetan ohikoagoak izanik [1,12, 16–22, 23–28,13]. Hala ere, badaude 2D:4D indizean sexuaren arabera estatistikoki esanguratsuak diren desberdintasunak aurkitu ez dituzten ikerketak ere [1,18,26].

1998. urtean izan zen 2D:4D indizeak ikertzaileen arreta bereganatu zuenean, noiz, fetuaren testosterona eta estradiol mailek 2D:4D indizearen formazioan eragiten zutela ikusi zen [10]. Ordutik, 2D:4D indizearekin ikertzeko interesa handituz joan da. Lutchmaya eta lankideak. (2004) lehenak izan ziren, likido amniotikoan neurtutako testosterona eta estradiol mailek 2D:4D indizearekin zuten korrelazioa aztertzen. Lan honek, bi aldagai hauen artean erlazioa zegoela erakutsi zuen, harremana estatistikoki esanguratsua izanik soilik eskuineko eskuetan [8]. Gizakietan egin diren ikerketa gehienek erakutsi dute, jaio aurreko androgeno eta estrogeno mailek 2D:4D indizearekin korrelazioa dutela, nahiz eta mekanismoak oraindik ezezagunak izan. Animaliekin, zehazki xaguekin egindako ikerketa batek ikusi zuen jaio aurreko androgeno eta estrogeno mailek 2D:4D indizea kontrolatzen zutela. Lan honek erakutsi zuen, 4. hatzak androgeno eta estrogeno hartzaile gehiago zituela 2. Hatzarekin alderatuz eta hartzaile hauen aktibitateak 2D:4D indizean eragiten zutela gene eskeletogenikoen espresioaren

eta zelulen espresioaren bitartez. Ondorioztatu zuten androgeno hartzaileen inaktibazioak 4. hazkundea gutxitzen zuela, 2D:4D ratio handiagoak lortuz. Eta bestalde, estrogeno mailen inaktibazioak 4. hatzaren hazkuntza sustatzen zuela, 2D:4D ratio txikiagoak lortuz.

Indize hau neurtzeko metodoari dagokionez, metodo zuzenak (kalibrea edo erregela erabiliz) eta zeharkakoak (eskaneatutako irudiak, fotokopiak, kamera digitalen irudiak edota X izpiak) erabili dira. Metodo zuzena, hatzak kalibre edo erregela baten bitartez neurtzean datza. Zeharkako metodoan, ordea, eskuaren irudia lortzen da (eskaneatuta, fotokopiatuta, kamera digitalak edo X izpiak erabiliz) eta ondoren, irudian hatzen neurketa egiten da kalibrea, erregela edo software espezifikoak erabiliz [16,19,25,29]. Alde batetik, neurketa zuzenen abantaila nagusiena da, metodo hauetan erabilitako materiala (kalibrea edo erregela) garraiatzeko erraza dela. Hala ere, metodo hauek baldintza esperimentalak mantentzeko zailtasunak izan ohi dituzte, hau da, neurketan zehar eskuak posizio berean mantentzeko zailtasunak agertu daitezke eta honek, neurketa akatsak agertzea errazten du. Bestalde, zeharkako neurketei dagokionez, datuak biltzeko denbora gutxiago behar dute eta irudiak behin-betiko gordetzeko aukera eskaintzen dute. Baina, metodo hauen desabantaila nagusia da, irudiak aztertzeko erabiltzen diren gailuak ez direla eramangarriak eta askotan garraiatzeko zailak direla. Gainera, ikerlariek, ez dute adostasunik erakutsi parte-hartzaileek gailuan (eskanerra edo fotokopiagailuan) egin behar duten presioari buruz, ezta behin irudiak lortuta, neurketak egiteko erabili beharreko prozeduraren inguruan ere.

Fidagarritasunari dagokionez, zuzeneko eta zeharkako metodoak alderatu dituzten ikerketek erakutsi dute, zeharkako metodoen behatzaile-barneko eta behatzaile-arteko fidagarritasuna handiagoa dela [16,17,19–21,24,27,28,30]. Era berean, zeharkako metodoen arteko desberdintasunak aztertu dituzten lanek frogatu dute, eskanerraren bidez lortutako

indizeak fotokopien bitartez neurtutakoak baina fidagarriagoak direla [16]. Eta, behin irudiak lortuta, neurketak egiteko prozeduretatik, irudien analisirako ordenagailuko programak erabiltzean fidagarritasun maila altuena erakutsi dituzte [16,22,31]. Hala ere, oraindik eztabaida handia dago komunitate zientifikoan. Esaterako, ikerketa batek ondorioztatu zuen lagin txikiekin metodo zuzena erabiltzea gomendagarria litzakeela eta, aldiz, lagin handietan edota datuak azkar jasotzea beharrezkoa denean zeharkako metodoak erabiltzea aukera egokiena litzatekeela [24].

Bi ikerketek, irudien analisirako ordenagailuko programa desberdinen fidagarritasuna konparatu zuten. Lan hauek, AutoMetric, GIMP eta Photoshop programek antzeko fidagarritasuna erakusten zutela ondorioztatu zuten. Nahiz eta, neurketak egiterako orduan, AutoMetrik programarekin, besteekin baino denbora gutxiago behar zela ikusi zen [1,31]. Hala ere, oraindik ez dago adostasun handirik, 2D:4D indizea neurtzeko metodo egokienaren inguruan; eta, oso ikerketa gutxik aztertu du, 2D:4D indizea neurtzeko irudien analisirako ordenagailuko programa desberdinek erakusten dituzten aldeak.

Lan honetan bi helburu proposatzen dira: lehenik, 11 urteko haurrengan 2D:4D indizea neurtzean, irudien analisirako ordenagailuko bi programek (AutoMetrik eta GIMP) erakusten duten behatzaile-barneko eta behatzaile-arteko fidagarritasuna aztertzea (Autometric and GIMP). Bigarrena, neurketak egitean programa bakoitzarekin behar den denbora ezagutzea.

2. MATERIALA ETA METODOAK

2.1. Partaideak

Parte-hartzaileak, INMA Proiektuko (Haurtzaroa eta Ingurumena, www.proyectoinma.org) Gipuzkoa kohorteko 11 urteko 180 haur izan ziren (%53,9 neskak eta %46,1 mutilak). INMA, Espainiako emakume haurdunen eta beren haurrak aztertzen dituen

kohorteen proiektu prospektiboa da [32]. Lan honetarako etika batzordearen (07/2008) onarpena eta gurasoen baimen informatuak lortu ziren.

2.2. 2D:4D indizearen neurketa

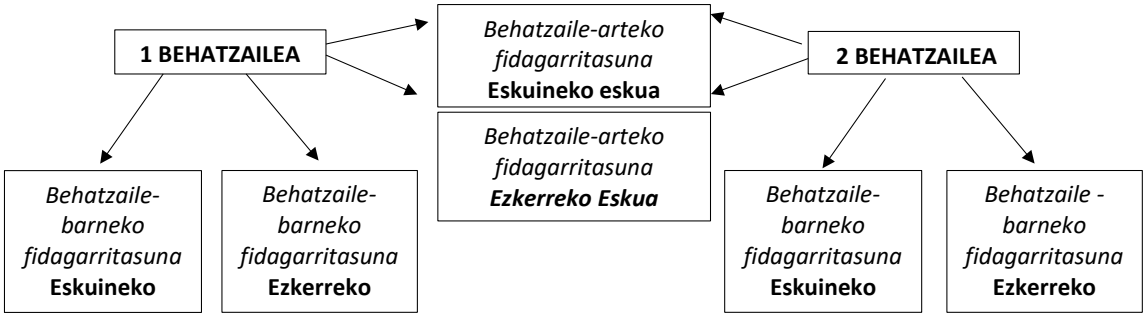
Behatzaile bakar batek haurren eskuen irudiak atera zituen eskaner eramangarri bat erabiliz (Epson Perfection V39). Eskuak eskaneatzeko, Micak eta lankideen 2016ko lana oinarritzat zuen *ad hoc* protokolo bat jarraitu zen. Behin eskuak eskaneatuta, irudiak ordenagailura pasa ziren, irudi analisien bi programa erabiliz hatzak neurtzeko eta ondorioz, indizeak kalkulatu ahal izateko. 2D:4D indizearen neurketak bi behatzailek egin zituzten. Behatzaile-barneko eta behatzaile-arteko fidagarritasuna neurtzeko helburuarekin, honako prozedura jarraitu zen: Behatzaile bakoitzak 2D:4D hiru aldiz kalkulatu zuen esku bakoitzeko. Partaideak 180 izanik, guztira 4320 neurketa egin ziren (180 parte hartzaile x 2 esku x 3 neurketa eskuko x 2 behatzaile x 2 programa). Behatzaile bakoitzak programa bakoitzarekin neurketak egiten igarotzen zuen denbora kalkulatu zen (behatzaile bakoitzak 20 parte hartzaileen neurketak egiten), eta bi metodoen konparazioa egiteko batez bestekoak erabili ziren.

Hatzak neurtu eta 2D:4D indizea neurtzeko erabili ziren irudien analisirako ordenagailu programak AutoMetric eta GIMP izan ziren. AutoMetric [33] doako programa da eta bi parametro ditu, lehenengoak bigarren hatzaren luzera neurtzeko balio du eta bigarrenak aldiz, laugarren hatzaren luzera neurtzeko. Behatzaileak lerro bat marraztu behar zuen hatz bakoitzaren tolesduraren erdialdetik, hatzaren puntaraino. Bi hatzen balioak erabiliz, programak automatikoki kalkulatzen zuen 2D:4D indizea. Bestalde, GIMP, irudi digitalak aztertzeko doako programa da [34]. Hatzen luzera neurtzeko, programak neurketarako tresna bat eskaintzen du eta, honek, hatzen beheko tolesturaren erdialdetik hatzaren puntaraino lerro

bat botatzea ahalbidetzen du. Aldiz, ez du 2D:4D indizea modu automatikoan kalkulatzeko aukera ematen.

2.3. Analisi estatistikoak

Datuak IBM SPSS 25 (Statistical Package for Social Science) programa erabiliz aztertu ziren. Lehenik eta behin, aldagaien normaltasuna konprobatu zen Kolmogorov-Smirnov estatistikoa kalkulatuz. Aldagai guztiek normaltasuna betetzen zutela ikusi zen (ikus 1. eranskina). Behatzaile-barneko eta behatzaile-arteko fidagarritasuna kalkulatzeko, klase-barneko korrelazio-koefizienteak (ICC: Infraclass Correlation Coefficient) erabili ziren. Behatzaile-barneko fidagarritasuna, pertsona batek egindako neurketen arteko akordioa bezala definitzen da, eta, behatzaile-arteko fidagarritasuna, aldiz, behatzaile ezberdinek egindako neurketen adostasunari dagokio.



1. ***Irudia:*** Fidagarritasuna kalkulatzeko prozedura

3. EMAITZAK

3.1. Behatzaile-barneko fidagarritasuna

Bi behatzaileek lortutako behatzaile-barneko fidagarritasuna altua izan zen programa bakoitzerako (ikus 1. eta 2. taulak).

1.Taula: Behatzaile-barneko fidagarritasuna AutoMetric programa erabiltzean

Behatzailea		Batez bestekoa (DT)	KBKK	KT95%		Estatistika	KBKK klasifikazioa
1 Behatzailea	**Eskuineko eskua**	0.966 (0.031)	0.995	0.993	0.996	187.104***	Bikaina
	Ezkerreko eskua	0.961 (0.032)	0.985	0.993	0.996	196.339***	Bikaina
2 Behatzailea	**Eskuineko eskua**	0.979 (0.035)	0.975	0.968	0.981	39.821***	Bikaina
	Ezkerreko eskua	0.973 (0.035)	0.972	0.964	0.979	35.82***	Bikaina

Notak: DT: Desbiderapen Tipikoa; KBKK=klase-barneko koefiziente korrelazioa, KT=konfiantza tartea; KBKK klasifikazioa (Rosner, 2011). KBKK< 0.7 ez onargarriak, 0.71 < KBKK < 0.79 onargarriak, 0.80 < KBKK < 0.89 oso onak eta KBKK >0.90 bikainak; *p<0.05; **p<0.01; ***p<0.001

2.Taula: Behatzaile barneko fidagarritasuna GIMP programa erabiltzean

Behatzailea	Eskua	Batez bestekoa (DT)	KBKK	KT 95%		Estatistika	KBKK klasifikazioa
1 Behatzailea	**Eskuineko eskua**	0.959 (0.031)	0.984	0.979	0.987	60.663***	Bikaina
	Ezkerreko eskuak	0.963 (0.035)	0.967	0.958	0.975	30.59***	Bikaina
2 Behatzailea	**Eskuineko eskua**	0.955 (0.032)	0.974	0.967	0.980	38.308***	Bikaina
	Ezkerreko eskuak	0.963 (0.033)	0.946	0.931	0.959	19.083***	Bikaina

Notak: KBKK=klase-barneko koefiziente korrelazioa, KT=konfiantza tartea; KBKK klasifikazioa (Rosner, 2011). KBKK< 0.7 ez onargarriak, 0.71 < KBKK < 0.79 onargarriak, 0.80 < KBKK < 0.89 oso onak eta KBKK >0.90 bikainak; *p<0.05; **p<0.01; ***p<0.001

3.2. Behatzaile-arteko fidagarritasuna

Bi programek behatzaile-arteko fidagarritasun maila egokia erakutsi zuten, nahiz eta, GIMP programaren fidagarritasuna altuagoa izan.

3.Taula: Behatzaile-arteko fidagarritasuna AutoMetrik eta GIMP erabiltzean

AutoMetric	GIMP

Eskua	Batez bestekoa (DT)	KBKK	KT 95%	KBKK klasifikazioa	Batez bestekoa (DT)	KBKK	KT 95%	KBKK klasifikazioa
Eskuinekoa	0,972 (0,030)	0,784	0,608-0,869	Onargarria	0,957 (0,029)	0,861	0,814-0,897	Oso ona
Ezkerrekoa	0,967 (0,030)	0,746	0,612-0,828	Onargarria	0,963 (0,031)	0,814	0,751-0,862	Oso ona

Notak: KBKK=klase-barneko koefiziente korrelazioa, KT=konfiantza tartea; KBKK klasifikazioa (Rosner, 2011). KBKK< 0.7 ez onargarriak, 0.71 < KBKK < 0.79 onargarriak, 0.80 < KBKK < 0.89 oso onak eta KBKK >0.90 bikainak; **p*<0.05; ***p*<0.01; ****p*<0.001

3.3. Neurketen ekonomia

GIMP programa erabiltzean, batez beste, behatzaile bakoitzak bi minutu eta erdi igaro zituen esku bakoitzeko; AutoMetric programa erabiltzean, ordea, minutu eta erdi.

4. EZTABAIDA

Ikerketa honek bi helburu zituen, lehenengoa 2D:4D indizea neurtzeko ordenagailuko bi programen fidagarritasuna ezagutzea. Bigarrena, programa bakoitzarekin egindako neurketen ekonomia aztertzea, programa bakoitzarekin neurketak egiten pasatako denbora kontrolatuz.

Lehenengo eta bigarren helburuei dagokionez, emaitzek, AutoMetric programa GIMP baina bizkorragoa dela, behatzaile barneko fidagarritasun ona duela, baina, behatzaileen arteko fidagarritasuna moderatua duela. Bestalde, GIMP programak behatzaile barneko eta behatzaile arteko fidagarritasun ona izan arren, denbora gehiago eskatzen du neurketak egiteko. Ikerketa honetako datuak bat datoz beste ikerketetan ikusitakoarekin. Lan honek, 2D:4D indizea neurtzeko irudi analisien bi programen fidagarritasunari buruzko informazioa eskaintzen du. Dakigunez, ikerketa gutxik konparatzen dute 2D:4D indizea neurtzeko ordenagailuzko metodoak [1,31]. Ikerketa hauek erakutsi dute AutoMetric programa egokiena dela denbora inbertsioari dagokionez [1,31]. Hala ere, gure ikerketan AutoMetric programak GIMP programak baino behatzaile arteko fidagarritasun altuagoa erakutsi du. Ildo honetatik, lan bakar

batek ikertu du bi programa hauen fidagarritasuna, eta erakutsi zuen, AutoMetric GIMP baino fidagarriagoa zela [1]. Hori dela eta, ondoriozta dezakegu ez dagoela programa hauen fidagarritasuna alderatzen duten azterketa nahikorik.

4.1. Indarguneak eta mugak

Ikerketa honek muga batzuk ditu. Lehenik, parte-hartzaile kopurua txikia da. Gainera, ikerketa honetan bi programa alderatzen dira eta ez eskuragarri dauden irudien analisirako ordenagailu programa guztiak, eta beraz, gertatu liteke beste software batzuk aztertutako programek baino fidagarritasun handiagoa erakustea. Hala ere, bi software hauek hautatu izanaren arrazoi nagusia da eskuragarriak eta doakoak direla eta AutoMetric programa, 2D:4D neurketak egiteko irudi analisien programa espezifikoa dela. Muga hauek eduki arren, lan honek 2D:4D fidagarritasunaren inguruko datu berriak eskaintzen ditu eta irudiak aztertzeko ordenagailuko bi programa alderatzen ditu.

4.2. Ondorioak

Gai honi buruzko ikerketa gehiago egin beharko lirateke, irudien analisi metodoen desberdintasunak aztertzen duten ikerketa kopuru urria dela eta. Etorkizuneko lanetarako, lagina zabaltzea eta adin desberdinetako pertsonen datuak erabiltzea interesgarria izan daiteke. Gai honetan ebidentzia berriak erakusteak, ebidentzian oinarritutako protokolo estandarizatu bat sortzen lagundu dezake, eta, horrela, 2D:4D indizearen neurketetan aldakortasuna murriztuko litzateke.

ESKER ONAK

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1.Eranskina: Aldagaien normaltasuna

Behatzailea	Programa	Eskua	Normaltasuna (Kolmogorov-Smirnov)
1. Behatzailea	**Autometric**	Eskuineko Eskua	*KS* (177)=0.046; *p*=0.200
		Ezkerreko eskua	*KS* (177)=0.044; *p*=0.200
	GIMP	Eskuineko eskua	*KS* (177)=0.031; *p*=0.200
		Ezkerreko eskua	*KS* (177)=0.033; *p*=0.200
2. Behatzailea	**Autometric**	Eskuineko Eskua	*KS* (177)=0.055; *p*=0.200
		Ezkerreko eskua	*KS* (177)=0.058; *p*=0.200
	GIMP	Eskuineko eskua	*KS* (177)=0.045; *p*=0.200
		Ezkerreko eskua	*KS* (177)=0.044; *p*=0.200

Soc., **126**, 5356 – 5357.

11.3. Listu Laginak Jasotzeko Protokoloa

Materiala

- Dokumentazioa prestatu: familientzat jarraibideak eta familiek bete beharreko galdetegia (azken astean haur edo aurrenerabeak hartutako medikazioa, izandako gaixotasunak edota estres egoerak).
- 50mL-ko bi hodi
- 2mL-ko polipropilenozko lau hodi
- Identifikazio zenbakia duten etiketak

Prozedura

1. Familiei listu laginak jasotzeko protokoloa telefonoz azaldu eta beharrezko dokumentazioa postaz bidali:

Listu lagin bat, besteak beste, testosterona eta estradiola bezalako sexu hormonak neurtzeko balio du. Bi hormona hauek, garapen sexualarekin harreman estua izateaz gain, zenbait funtzio kognitiborekin erlazionatuta dago. Zenbat ikerketek, hormona hauen maila eta garapen psikologikoen artean harremana topatu dute nerabeetan. Hori dela medio, INMA proiektuaren parte bezala, zuen haurren testosterona eta estradiol mailak neurtzea proposatzen dugu listu lagin baten bitartez. Prozedura hau ez da kaltegarria eta etxean burutu daiteke, hormona hauen mailak egun eta asteetan zehar aldatzen baita.

<u>Laginak jasotzea:</u>

1. *Laginak bi egun desberdinetan jaso behar dira, eta egun hauen artean 7 eguneko tartea egon behar du (ASTELEHEN-ASTELEHEN; ASTEARTE-ASTEARTE…).*
2. *Egun hauetako bakoitzean listu lagin bat jasoko da goizean, 08:00ak inguruan.*

3. *Erregistro orrian, lagin bakoitza jaso den ordu zehatza eta lagina jasotzean sortu daitezkeen intzidentzia posibleak apuntatuko dira.*
4. *Lagina beti gosaldu aurretik jasoko da. Haurra esnatu eta 15 minutu itxaron beharko dira gutxienez lagina jasotzeko. Hauek horrela, erregistro orrian, haurra esnatu den ordua ere erregistratuko da.*
5. *Listua jaso aurretiko orduan haurrak ez du ezer jango*
6. *Listua jaso aurretiko bi ordutan ez ditu hortzak garbituko.*
7. *Lagina jaso baina 24h aurretik haurra ez da dentistan izango.*
8. *Listu lagina jaso aurretik (10 minutu aurretik), haurrak ahoa urarekin garbituko du.*
9. *Listu jarioa estimulatzeko, limoi zati bat edota gozoki batzuk erakutsi ahalko zaizkio. Posible da baita, gustuko duen jaki batean pentsatzeko eskatzea ere.*
10. *Behin ahoan listua sortu dela, haurrak bere listua, erroskako tapoia duten 50mlko ontzi batean bota beharko du, gutxienez 10ml-ko kantitatea jariatuz.*
11. *Behin ontziak beteta eta itxita, hozkailuan 4ºC gordeko dira, bisitan entregatzen diren arte.*
12. *Prozedura hau berdina izango da lehen eguneko eta bigarren eguneko listu laginak jasotzeko.*
13. *Familiek etxean jaso dituzten laginak ekarriko dituzte. Laginak ongi etiketatuak daudela eta galdetegia bete dutela konprobatu beharko du landa laneko ikertzaile arduradunak.*
14. *Lehen eguneko listua, 2mL-ko bi hoditara pasa. Berdina errepikatu bigarren eguneko laginarekin.*

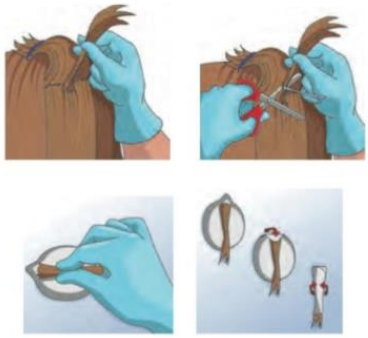
11.4 Ileko lagina

Materiala

- 1cm2-ko zuloa duen plastikozko plaka
- Ileko goma txikiak
- Ileko pintzak
- Guraizeak
- Filtrozko papera
- Zip poltsa

Prozedura

1. Bisita aurretik haur edo aurrenerabeen gurazoei informatu beharko zaie, aurreko egunean haur edo aurrenerabeak ilea uraz soilik garbitzeko. Era berean aurreko astetan ilea ez moztea edota parasitoen (zorrien) kontrako tratamendurik ez hartzea.
2. Ilea, buruko atzeko bertex areako larruazaletik gertu moztu beharko da. Larruazaleko lesiorik ez duen gune batean.
3. Beharrezkoa den kopurua hartzeko asmoz, plastikozko plaka erabiliko da, zulotik ile -sorta sartuaz.
4. Pintza batez lagunduz, ileko zati distala helduko da eta larruazaletik ahalik eta gertuen, guraizeak erabiliz, ile-sorta bat moztuko da.
5. Ilearen mutur distala desberdintzeko asmoz, goma txiki bat ipiniko da.
6. Lagina filtrozko paperean bilduko da eta plastikozko poltsan sartuko da.
7. Lagina parte-hartzailearen ID zenbakia erabiliz identifikatuko da.
8. Prozedura erregistratuko da: lagina hartu den gunea, haur edo aurrenerabeak aurreko egunetan erabili dituen ileko produktuak, ilea xaboiaz garbitu duen azken eguna…



IZARO BABARRO VELEZ

Doktorego tesia
Doctoral thesis
2022