Multivarijatno višerazinsko modeliranje: mogućnosti primjene u društvenim znanostima

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MULTIVARIJATNO VIŠERAZINSKO MODELIRANJE:
MOGUĆNOSTI PRIMJENE U DRUŠTVENIM ZNANOSTIMA

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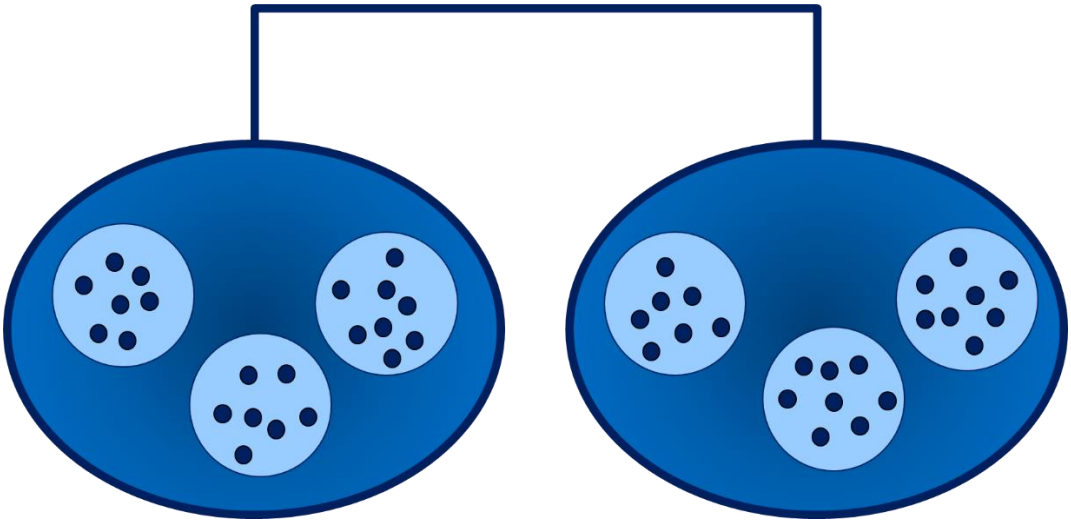

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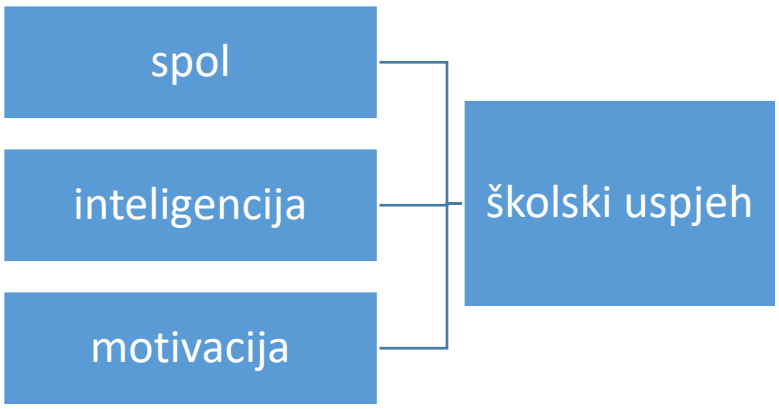
1. PREDNOSTI KORIŠTENJA VIŠERAZINSKOG MODELIRANJA NAD REGRESIJSKOM ANALIZOM

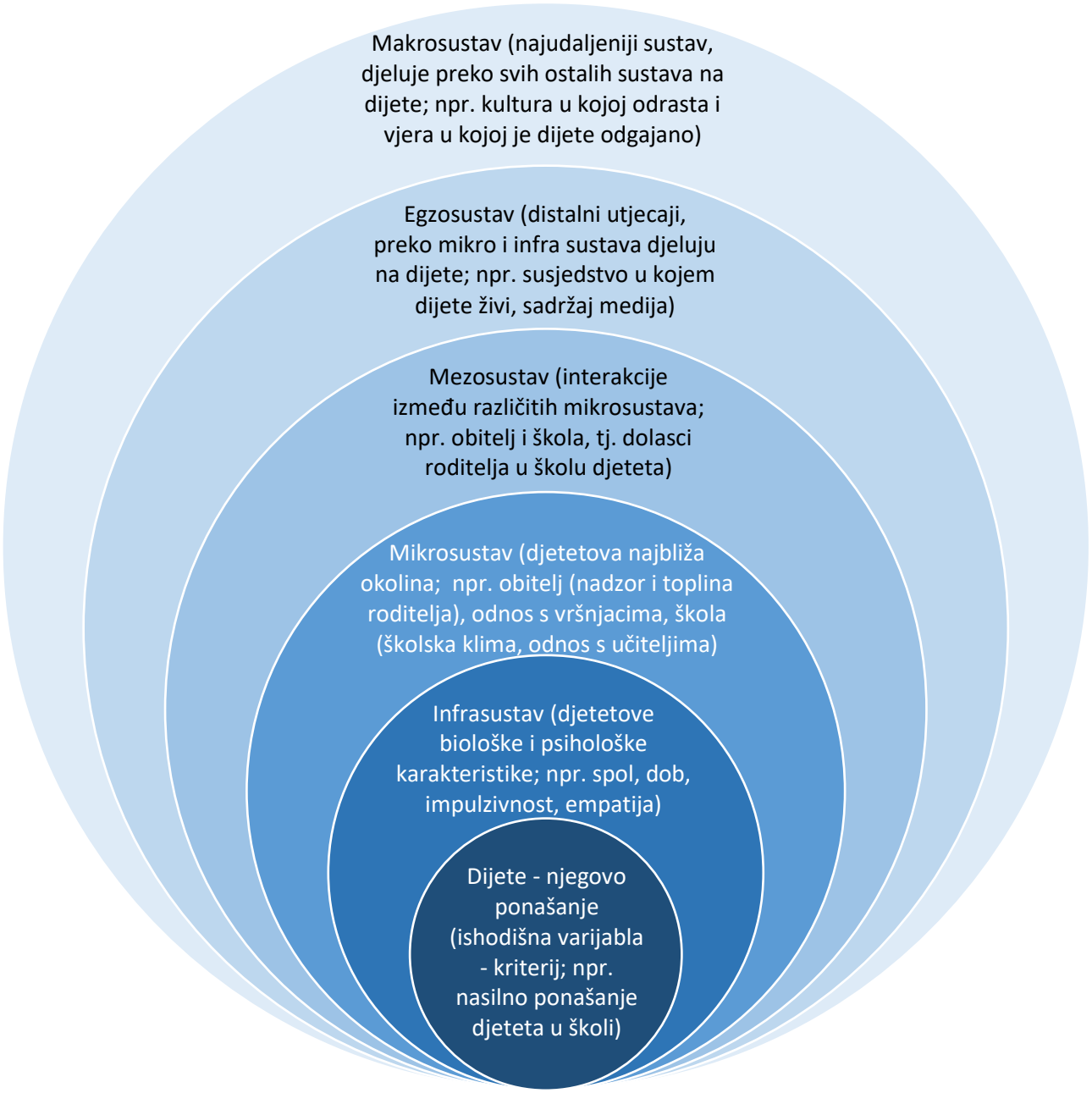
U društvenim istraživanjima jedna od glavnih zadaća je predviđanje određenog ponašanja. U tu svrhu najčešće koristimo tzv. regresijsku analizu. U regresijskoj analizi na temelju skupa određenih varijabli, koje nazivamo prediktori, pokušavamo predvidjeti određeni ishod (najčešće ponašanje), odnosno neku drugu varijablu koju nazivamo kriterij. Na primjer, u području psihologije odgoja i obrazovanja važno nam je znati o čemu sve ovisi školski uspjeh učenika, odnosno na temelju kojih varijabli ga možemo predvidjeti (slika 1). U ovom primjeru školski uspjeh je naša ishodišna varijabla, tj. kriterij, kojeg pokušavamo predvidjeti na temelju nekih drugih varijabli. Brojna su istraživanja pokazala kako je za školski uspjeh važna inteligencija učenika, motivacija za učenje, a u osnovnoj školi i spol učenika. Ove varijable nazivaju se prediktori jer temeljem njih predviđamo školski uspjeh učenika. Tako npr. djevojčice (ženski spol), višeg stupanja inteligencije i veće razine motivacije za učenjem postižu bolji školskih uspjeh (bolje ocjene).



Slika 1. Prikaz regresijskog modela na primjeru školskog uspjeha (kriterija) kojeg predviđaju tri varijable (prediktori): spol, inteligencija i motivacija

Međutim ima puno situacija u stvarnom životu kada stvari nisu tako jednostavno posložene, kao u gore opisanom primjeru, već su poprilično složene i međusobno isprepletene. Dobar primjer za to je Bronfenbrennerov ekološki model ljudskog ponašanja (Bronfenbrenner, 1986). Ovaj model pretpostavlja da je dijete, odnosno njegovo ponašanje koje promatramo (koje je u ovom slučaju ishodišna ili kriterijska varijabla) u interakciji s okolinom u kojoj odrasta (slika 2). Dijete, odnosno individua, predstavljeno je pomoću psiholoških i bioloških osobina što predstavlja individualnu razinu ekološkog modela (infrasustav). Ovo su osobine koje određuju ponašanje djeteta, npr. spol i dob djeteta, crte ličnosti, razina empatije i impulzivnosti i dr. Samo dijete, sa svim svojim karakteristikama, okruženo je okolinom, poput koncentričnih kružnica. Najbliža

djetetova okolina je mikrosustav te ima neposredan utjecaj na djetetovo ponašanje. Najčešće se to odnosi na obitelj (odnos s roditeljima, stil odgoja i sl.), vršnjake (s kim i kako dijete provodi slobodno vrijeme) te školu (školska klima, odnos s učiteljima i dr.). Mezosustav se sastoji od interakcija mikrosustava, a najčešće se proučavaju interakcije obiteljskog i školskog sustava (npr. odlazak roditelja u školu na informacije) te interakcije obiteljskog i vršnjačkog sustava (npr. roditeljsko nadgledanje za vrijeme djetetove igre s vršnjacima). Distalni utjecaj na dijete ima egzosustav i makrosustav. Egzosustav se odnosi na okolinu u kojoj dijete ne sudjeluje aktivno, ali ipak ta okolina ima posredni utjecaj na njegovo ponašanje preko bližih sustava (infrasustav i makrosustav). Tako npr. zajednica i susjedstvo u kojem dijete odrasta ima utjecaj na ponašanje njegove obitelji, ali i na razvoj određenih osobina. Uzmimo za primjer dijete koje odrasta u nasilnom susjedstvu što može direktno utjecati na to da dijete uči nasilno ponašanje svakodnevno ga promatrajući i onda prenosi to nasilno ponašanje i u školsko okruženje. Također, svakodnevnim promatranjem nasilja postajemo tolerantniji na nasilje, pa posljedično djeca mogu razviti i slabiju empatiju. Istovremeno roditelji u nasilnim zajednicama mogu biti restriktivniji prema djeci želeći ih na taj način zaštiti i pri tome ih češće kažnjavati (što opet može dovesti do djetetovog nasilnog ponašanja u školi). Najudaljeniji sustav je makrosustav, koji također nema neposredni već samo posredni, preko bližih sustava, utjecaj na dijete. Dobar primjer je kultura u kojoj dijete odrasta (npr. tradicionalna kultura u kojoj je opravdano fizičko kažnjavanje, a koje dovodi do razvoja nasilnog ponašanja djece) ili religija u kojoj se dijete odgaja, a koja ima svoj određeni vrijednosni sustav što će utjecati i na razvoj vrijednosti, normi i stavova kod djeteta. Promatrajući ovaj model možemo primijetiti kako su sve varijable sa različitih razina sustava (infra, mikro, mezo, egzo i makro sustav) zapravo potencijalni prediktori koji pokušavaju objasniti i predvidjeti djetetovo ponašanje. No, za razliku od prvog, jednostavnog regresijskog modela (slika 1), u ovom modelu se dodatno isprepliću varijable s različitih razina sustava (npr. varijable egzosustava utječu na djetetovo ponašanje samo preko varijabli s razine infra i mikro sustava), a na pojedinim razinama prediktori su međusobno u interakciji te zajedno utječu na ponašanje djeteta (npr. mezosustav gdje na djetetovo ponašanje utječe odnos roditelja sa školom). Upravo zbog složenosti ljudskog ponašanja često ga nije moguće objasniti i predviđati jednostavnijim regresijskim modelima, već su u tu svrhu potrebniji složeniji modeli kao što je multivarijatno višerazinsko modeliranje.



Slika 2. Prikaz Bronfenbrennerovog ekološkog modela na primjeru dječjeg nasilnog ponašanja

Višerazinski regresijski model (ili tzv. hijerarhijski linearni model) pretpostavlja hijerarhijski organizirane podatke, s jednom varijablom (kriterijem ili zavisnom varijablom) mjerenom na najnižoj razini (u našem primjeru to će biti stupanj nasilnog ponašanja djeteta) te ostalim eksploratornim varijablama na svim drugim postojećim razinama (slika 2). Konceptualno gledano takav model predstavlja hijerarhijski sustav regresijskih jednadžbi. Za razliku od regresijske analize, koja daje objašnjenje unutar jedne razine (kovariranje unutar klastera; u našem primjeru sa školskim uspjehom sve varijable koje su potencijalni prediktori mjerene su na jednoj individualnoj razini, odnose se na pojedinca, tj. spol, inteligencija i motivacija su potencijalni prediktori), višerazinsko modeliranje uzima u obzir i povezanost između razina (odnosno između

klastera; tj. u našem primjeru između različitih razina ekološkog modela, npr. makro (religija) i mikro (roditelji) razine sustava koje zajednički djeluju na kriterij – djetetovo nasilno ponašanje) što mu je glavna prednost nad regresijskom analizom. U psihološkim (i općenito društvenim) istraživanjima pokazale su se važnim kontekstualne varijable, koje uvelike mogu utjecati na krajnji ishod. Npr. školska klima je kontekstualna varijabla, koja može utjecati na vezu između impulzivnosti i nasilnog ponašanja tako da u školama gdje postoji pozitivna školska klima veza između impulzivnost i nasilja se smanjenju je (ili postaje čak neznačajna), dok u školama gdje prevladava negativna školska klima ova veza se pojačava. Upravo nam višerazinsko modeliranje omogućuje ispitivanje utjecaja individualnih varijabli (u našem primjeru impulzivnosti) i kontekstualnih varijabli (školske klime) primjenjujući jednu analizu, kada su varijable s jedne razine ugniježdene na drugoj razini (npr. učenici se nalaze unutar razreda, razredi unutar škola (slika 4); ili kao što je i prikazano koncentričnim kružnicama u Bronfenbrennerovom modelu, slika 2).

U regresijskoj analizi kao jedan od krajnjih ishoda dobivamo mjeru koja se naziva proporcija objašnjenja varijanca (R^2). Taj nam podatak (u obliku proporcije) govori koliko smo dobro našim potencijalnim prediktorima (npr. spol, inteligencija i motivacija) uspjeli objasniti kriterijsku varijablu (npr. školski uspjeh). Međutim kada imamo više razina modela (kao što je to u Bronfenbrennerovom modelu) onda nije valjano zaključivati o ukupno objašnjenoj varijanci, već nas više zanima koliko su dobro potencijalni prediktori na svakoj razini (npr. obiteljske varijable na mikro razini ili uloga medija na egzo razini) objasnili i predvidjeli kriterijsku varijablu (npr. nasilno ponašanje djeteta). Višerazinsko modeliranje (*eng. multilevel modeling*) omogućuje rastavljanje varijance kriterija (npr. djetetovo nasilno ponašanje) na različite razine i objašnjenje te varijance varijablama sa svake određene razine (npr. objašnjenje varijance individualnim varijablama (impulzivnost) za prvu razinu i objašnjenje varijance kontekstualnim varijablama (školska klima) za drugu razinu). Nadalje omogućuje ispitivanje interakcije ne samo na jednoj razini, nego i interakcija između različitih razina, odnosno interakcija varijabli s različitih razina modela (npr. interakcije egzo i infra sustava, odnosno interakciju između uloge medija i razine empatije kod djeteta, koje zajednički djeluju na djetetovo nasilno ponašanje).

Za razliku od regresijske analize višerazinsko modeliranje je robusnija metoda. Ne pretpostavlja homogenost regresijskih pravaca, odnosno veza između prediktora i kriterija ne mora biti ista za različite grupe, jer višerazinski modeli objašnjavaju varijabilnost u regresijskim pravcima različitih grupa. Osim toga nema pretpostavke o nezavisnosti, odnosno da su opažanja nezavisna što znači da možemo imati istovremeno više kriterija (*eng. multivariate mulitlevel modeling;* npr. kriterij nije samo učiteljeva procjena nasilnog ponašanje djeteta nego kombinacija više različitih procjena, tj. kombinacije procjena učitelja, vršnjaka i samog djeteta) ili mjerenja u više vremenskih točki (npr. na početku i kraju školske godine). Za razliku od većine ostalih analiza (ANOVA, regresija i sl.) kod višerazinskog modeliranja nema problema s podacima koji nedostaju (*eng. missing data*) jer su na višim razinama analize uzima prosjek određene grupe (npr. razreda ili škole, a ne individualni podaci).

2. PREDUVJETI ZA PROVOĐENJE VIŠERAZINSKOG MODELIRANJA

Višerazinsko modeliranje zapravo je nadogradnja regresijske analize stoga se pretpostavke za provođenje regresijske analize mogu primijeniti i za provođenje višerazinskog modeliranja. Ukratko ćemo ponoviti te pretpostavke:

1. Tip varijabli u regresijskoj analizi se razlikuje ovisno radi li se o prediktorskim ili kriterijskim varijablama. Sve prediktorske varijable moraju biti kvantitativne ili kategorijalne (2 kategorije), dok kriterijska varijabla treba biti kontinuirana, punog raspona i mjerena na intervalnom nivou.

2. Prediktori ne smiju imati varijancu nula, odnosno moraju imati neku varijaciju u vrijednostima.

3. Ne postoji savršena multikolinearnost. Nema savršene linearne veze između dva ili više prediktora. Što bi značilo da ne postoje korelacije veće od 0,8 između prediktora, odnosno da VIF (faktor inflacije varijance) nije veći od 10 (ukazuje da li prediktor ima jaku linearnu vezu s nekim drugim prediktorom), a statistika tolerancije nije manja od 0,2 (ukazuje na postojanje problema vezanog uz multikolinearnost).

4. Prediktori nisu u korelaciji s vanjskim varijablama, odnosno ne postoji treća varijabla (koju nismo uključili u model) koja bi utjecala na povezanost prediktora i kriterija.

5. Potrebna je homoscedastičnost, odnosno homogenost varijance, što bi značilo da reziduali na svakoj razini prediktora trebaju imati jednake varijance. Ova pretpostavka se može provjeriti pomoću Levenovog testa. Ako Levenov test nije statistički značajan varijance su homogene. Kod velikog uzorka i mala odstupanja unutar grupe mogu dovesti do značajnosti Levenovog testa stoga je kod velikog uzorka dobro provjeriti i Hartley's Fmax test, odnosno test omjera varijanci između grupe s najvećom i grupe s najmanjom varijancom.

6. Nezavisnost pogreške, što bi značilo da za bilo koja dva opažanja reziduali nisu u korelaciji, odnosno da su nezavisni. Ovu pretpostavku možemo testirati Durbin-Watson testom. Rezultat testa od 2 znači da nema korelacija (potpuno nezavisne pogreške), a prihvatljive su sve vrijednosti ako su nalaze između 1 i 3.

7. Normalna distribucija pogrešaka, odnosno da su reziduali slučajne, normalno distribuirane varijable s aritmetičkom sredinom jednakoj 0. Ovo zapravo znači da su razlike između modela i opažanih podataka najčešće 0 ili jako blizu 0. Ovo ne treba miješati s normalnom distribucijom prediktora, jer prediktori ne moraju imati normalnu distribuciju.

8. Nezavisnost, što bi značilo da sve vrijednosti ishodišne varijable (odnosno kriterija) trebaju biti nezavisne.

9. Linearnost, odnosni se na činjenicu da bi sve veze između kriterija i prediktora trebale biti linearne (jer se i radi o linearnim modelima). Možemo provjeriti crtanjem dijagrama raspršenja (*eng. scatter plot*).

Međutim, kako je višerazinsko modeliranje robustnija metoda neki od preduvjeta za provođenje regresijske analize nisu nužni da bi se moglo provesti višerazinsko modeliranje. Nije potrebna nezavisnost pogreške i općenito nezavisnost (nezavisni kriteriji) jer nedostatak nezavisnosti mogu uzrokovati varijable s više razine (druge, treće ili četvrte razine), a višerazinskim modeliranjem taj se problem rješava.

3. MULTIVARIJATNO VIŠERAZINSKO MODELIRANJE (ENG. MULTIVARIATE MULTILEVEL MODELING - MMLM)

Multivarijatno višerazinsko modeliranje zapravo je samo jedna od inačica primjene osnovnog višerazinskog modela s tri razine. Preduvjeti za korištenje ove metode jednaki su općenito preduvjetima za primjenu višerazinskog modeliranja. Ovaj model se primjenjuje kada postoji više od 1 zavisne varijable (tj. kriterija) i niz nezavisnih varijabli na različitim razinama (tj. niz prediktora kao i u ostalim višerazinskim modelima). Glavna prednost ovog modela je mogućnost ispitivanja složenih modela koji imaju više ishodišnih varijabli (*eng. outcome*).

Na prvoj razini modela (level 1) definira se mjerni model koji se sastoji od više ishodišnih odnosno kriterijskih varijabli i tako se dobiva multivarijatni ishod, odnosno kriterij (tablica 1). U našem primjeru mjera ukupnog nasilnog ponašanja djeteta sastoji se od 3 različite mjere: 1) samoprocjena nasilnog ponašanja na temelju opisa ponašanja (na 19 čestica dijete je procijenilo na skali Likertovog tipa s 5 stupnjeva koliko često radi svako opisano ponašanje ; 2) nominacija od strane vršnjaka (dijete je za svakog učenika u svom razredu trebalo označiti je li jedno od opisanog ponašanja čini češće nego druga djeca; ukupno su bila opisana tri ponašanja: tjelesno nasilje prema vršnjacima, verbalno nasilje prema vršnjacima i elektroničko nasilje prema vršnjacima); 3) samoprocjena ponašanja na temelju definicijskog pristupa (dijete je procijenilo za sebe čini li neko od tri opisana ponašanja češće nego njegovi vršnjaci: tjelesno nasilje prema vršnjacima, verbalno nasilje prema vršnjacima i elektroničko nasilje prema vršnjacima). Kombinirajući te tri mjere dobivamo novi latentni konstrukt (latentni se konstrukt odnosi na varijablu koja nije „vidljiva“ jer zapravo to nova varijabla nastala kombinacijom postojećih mjerenih varijabli, a nije izravno mjerena u samom istraživanju) ukupnog nasilnog ponašanja djeteta.

Bitno je da su sve tri mjere nasilnog ponašanja dobivene na istoj skali kada želimo od njih stvoriti novi latentni konstrukt. Kako to u našem primjeru nije bio slučaju (za samoprocjenu nasilnog ponašanja raspon se kretao do 1 do 5 (od nikad do uvijek), nominacija vršnjaka je zapravo bila proporcija nominacije učenika unutar razreda, a samoprocjena na temelju definicijskog pristupa se kretala od 0 (nisu se procijenili nasilno niti za jednu vrstu nasilja) do 3 (procijenili su se nasilno na sve tri vrste nasilja, verbalno, tjelesno i elektroničko), bilo je potrebno sve tri mjere svesti na standardiziranu ljestvicu, odnosno na z-vrijednosti.

Na drugoj razini modela (level 2) definiraju se varijable koje variraju unutar grupe ili klastera (odnosno unutar razreda, ali između učenika). U našem primjeru to su bile individualne, školske, vršnjačke i obiteljske karakteristike. Ukupno smo imali 14 takvih varijabli (empatija, vrijeme provedeno uz medije, impulzivnost, broj prijatelja, prihvaćenost od strane vršnjaka, prosjek ocjena, opasnost susjedstva, pozitivna roditeljska disciplina, negativna roditeljska disciplina, prihvaćanje roditelja, autonomija roditelja, psihološka kontrola roditelja, nadzor roditelja, popustljivost roditelja). Radi lakše interpretacije sve varijable su centrirane oko prosjeka cijelog uzorka (*eng. grand-mean centring*). Ovaj način centriranja varijabli je uobičajen za višerazinsko

modeliranje, a omogućava nam da i 0 ima smislenu interpretaciju. Također pomaže i ako postoji multikolinearnost između prediktora, omogućuje veću stabilnost modela, a i procjene parametara se mogu se tretirati kao međusobno nezavisne što je poželjno. Kod interpretacije to znači da uspoređujemo pojedinca u odnosu na uzorak (za koji pretpostavljamo da reprezentira populaciju) na kojemu je vršeno mjerenje. Nula predstavlja aritmetičku sredinu, rezultati iznad nule su veći od aritmetičke sredine uzorka, a rezultati manji od 0 su ispodprosječne vrijednosti (npr. ako je 0 aritmetička sredina uzorka za impulzivnost, sve što je iznad 0 označava veći stupanj impulzivnosti u odnosu na prosjek, a sve ispod 0 manji stupanj impulzivnosti u odnosu na prosjek). Bitno je naglasiti da distribucija rezultata ostaje jednaka nakon ovog centriranja. Ukoliko centriramo na ovaj način originalni rezultati (*eng. raw scores*), predviđanje vrijednosti i reziduali ostat će jednaki kao i pristajanje modela podacima (*eng. model fit*), no sami parametri će se promijeniti (beta, regresijski koeficijenti), ali će i dalje ostati direktno povezani s originalnim parametrima (može se postići pretvorba jednih u druge pomoću transformacija). Stoga centriranje oko prosjeka uzorka ne mijenja sam model nego samo interpretaciju parametara. Drugi oblik centriranja podataka (koji mi nismo primijenili) je centriranje oko grupnog prosjeka (*eng. group-mean centring*), odnosno uspoređujemo pojedinca u odnosu na grupu (učenika u odnosu na prosjek učenika za razred koji pohađa). Međutim, interpretacija ovako centriranih varijabli je puno teža i kompliciranija. Ukoliko centriramo na ovaj način originalne rezultate (*eng. raw scores*) pristajanje modela podacima (*eng. fitting*) neće biti isto, a mijenjat će se i procjene parametara. Ovakvo centriranje mijenja sam model i puno ga je teže interpretirati.

Na trećoj razini (level 3) definiraju se varijable koje variraju između grupe ili klastera (odnosno između razreda). Na ovaj razini smo definirali 3 varijable (školska klima, dolasci roditelja u školu i indeks nejednakosti prihoda) koje smo također centrirali oko prosjeka cijelog uzorka radi lakše interpretacije.

Na četvrtoj razini mogle bi se definirati varijable koje variraju između škole (npr. školska klima na razini škole ili školska politika), ali u našem primjeru nije postojala statistička značajna varijacija između škola (manje od 5% varijabiliteta između škola) stoga nije niti imalo potrebe uvoditi varijable na ovoj razini nego smo se zadržali na prethodne opisane tri razine.

Osim navedenog bilo je potrebno i dodatno pripremiti rezultate za obradu. U tu svrhu izbacili smo sve sudionike unutar razreda gdje je ukupni odaziv sudionika u istraživanju bio manji od 50%. Ukupno je 38 učenika isključeno (5 razreda) jer je u istraživanju sudjelovalo manje od 50% učenika tog razreda. Druga važna stvar je priprema seta podataka. Uobičajena struktura podataka u SPSS-u je horizontalna, odnosno u jednom redu su podaci za jednog sudionika. Međutim kod multivarijatnog višerazinskog modeliranja potrebno je restrukturirati podatke tako da budu organizirani vertikalno. Na taj način nam je omogućeno da unutar jednog pojedinca uklopimo više kriterijskih varijabli (ili više vremenskih točki), odnosno u našem primjeru za svako dijete su trebale biti uklopljene tri kriterijske varijable (samoprocjena nasilnog ponašanja na temelju opisa ponašanja, nominacija od strane vršnjaka i samoprocjena ponašanja na temelju definicijskog pristupa). Tako sada naše kriterijske varijable ugniježđene unutar pojedinca postaju prva razina,

individualne, školske, vršnjačke i obiteljske karakteristike pojedinca druga razina, karakteristike razreda 3 razina, a karakteristike škole četvrta razina višerazinskog modela (tablica 1, slika 3). Unutar strukture podataka to bi značilo da će svaki pojedinac (učenik) imati višestruke podatke. Ako postoje tri kriterija (kao u našem primjeru) svaki će učenik imati 3 skupine podataka (3 reda će se odnositi na jednog učenika, a ne kao dosad jedan red = jedan učenik), svaku za pojedini kriteriji (iako se ti podaci, osim u kriteriju, neće međusobno razlikovati već ponavljati). Odnosno ako imamo 800 sudionika, sada će izgledati kao da imamo 3x800, odnosno 2400 unosa - redova (trostruko više unosa za svakog pojedinca). Posljednja bitna stvar kod pripreme je kreirati varijablu koja će biti poveznica između različitih razina. Npr. redni broj u novo strukturiranim podacima bit će poveznica za sva tri kriterija, odnosno tri reda horizontalnih podataka imat će isti redni broj koji će označavati da se ti podaci odnose na jednog te istog učenika. U našem primjeru potrebna je još jedna nova varijabla koja će označavati poveznicu između učenika i razreda, što će značiti da se svi učenici koji pohađaju isti razred označavaju jednako unutar te nove varijable (raspon ove varijable jednak je broju razreda uključenih u istraživanje).

Tablica 1. Prikaz varijabli korištenih u primjeru koji opisujemo

Varijable		N	Min	Max	M(p)	sd
Kriterijske varijable na 1. razini (multivarijntni ishod)						
Samoprocjena ukupnog nasilja (ponašajni pristup)		879	1,00	3,42	1,30	,30
Samoprocjena ukupnog nasilja (definicijski pristup)		720	,00	3,00	,46	,72
Nominacija vršnjaka za ukupno nasilje (definicijski pristup)		720	,00	3,00	,24	,56
Prediktorske varijable na 2. razini						
Individualne osobine	empatija afektivni aspekt	879	,20	4,00	2,96	,70
	ukupno vrijeme provedeno uz medije	873	1,00	5,00	2,83	,87
	impulzivnost	869	1,00	5,00	2,40	,79
Obitelj	pozitivna roditeljska disciplina	877	1,00	4,00	3,12	,64
	negativna roditeljska disciplina	874	1,00	4,00	2,11	,63
	prihvaćanje roditelja	874	1,00	4,00	3,56	,52
	autonomija roditelja	872	1,00	4,00	3,52	,50
	psihološka kontrola roditelja	870	1,00	4,00	2,17	,69
	nadzor roditelja	874	1,00	4,00	3,17	,64
	popustljivost roditelja	875	1,00	4,00	2,43	,65
Škola	prosjek ocjena	876	1,17	5,00	3,75	,89
Vršnjaci	broj najboljih prijatelja	879	0	25	4,34	3,51
	prosječna prihvaćenost vršnjaka	879	1,00	3,00	2,64	,48
Susjedstvo	opasnost susjedstva	870	1,00	5,00	4,18	,76
Prediktorske varijable na 3. razini						
Indeks nejednakosti prihoda		880	,02	,17	,09	,03
Dolasci na roditeljske sastanke i informacije te školska zbivanja		880	1,68	3	2,26	,29
Školska klima – procjena razreda		880	1,41	3,35	2,32	,42
Prediktorske varijable na 4. razini (nisu uzete u daljnju obradu jer nije bilo variranja između škola)						
Školska klima – samoprocjena nastavnika		880	1,92	2,22	2,04	,10
Školska politika protiv nasilja		880	,75	,94	,86	,07

p – proporcija nominacija

4. VAŽNOST MUTIVARIJANTNOG VIŠERAZINSKOG MODELIRANJA ZA DRUŠTVENE ZNANOSTI

Za provođenje višerazinskog modeliranja postoje dva razloga. **Prvi je statistički**, a odnosi se na primijenjenu metodologiju, tj. na način na koji smo mjerili pretpostavljene varijable i njihove odnose. Prijašnje su analize (npr. MANOVA, regresijska analiza i dr.) sve varijable mjerile na jednoj razini, i to na individualnoj, odnosno na razini pojedinca. Na taj način, zbog ignoriranja utjecaja konteksta, regresijski koeficijenti su se primjenjivali jednako na sve kontekste ne uzimajući u obzir njihovu povezanost i moguće interakcije (što može dovesti do zaključka da su pojedini prediktori statistički značajni kada u stvarnosti nema statističke značajnosti). Stoga, kada su podaci hijerarhijski organizirani (učenici unutar razreda, razredi unutar škole, škole unutar zajednica ili gradova, itd.) potrebno je primjenjivati višerazinsko modeliranje. Ipak, to ne znači da se barem neki podaci ne mogu sakupiti na individualnoj razini (npr. učenička percepcija školske klime), ali se u modelu putem agregacije (grupiranje) mogu primjenjivati na višoj razini (npr. percepciju školske klime kao varijablu mjerenu na individualnoj razini možemo agregacijom u modelu postaviti na višu razinu (razrednu) ako tu varijablu tretiramo kao prosječnu školsku klimu razreda, tj. za svaki razred izračunamo aritmetičku sredinu percepcije školske klime svih učenika koji pohađaju taj razred). U našem primjeru postoje dvije razine mjerenja (odnosno prikupljanja podataka). Prva razina se odnosi na pojedince (individualna razina), a druga razina odnosi se na podatke prikupljene za razrede (grupna razina). Možemo pretpostaviti i postojanje treće razine (škole) koja se u opisanom primjerom nije pokazala značajnom. Zbog toga smo varijable mjerene na školskoj razini (školska klima) koje smo mogli segregacijom spustiti na nižu razinu (razredna razina) u konačnom prikazanom modelu obradili na taj način kako bismo zadržali varijable koje su nam potencijalno od velike značajnosti.

Drugi razlog za provođenje višerazinskog modeliranja je teorijske prirode. Ukoliko pretpostavljamo postojanje utjecaja socijalnog konteksta na pojedinca, ti utjecaji, kao i njihove interakcije nužno pretpostavljaju postojanje više razina (pojedinac je uklopljen u različite socijalne kontekste koji su u međusobnoj interakciji). Kada provodimo istraživanje koje je po prirodi višerazinsko i teorijska podloga takvog istraživanja također treba biti višerazinska. Upravo Bronfenbrennerov ekološki model pretpostavlja hijerarhijski organizirane razine sustava koje djeluju na djetetovo ponašanje (slika 2). U našem istraživanju varijable na određenim razinama ekološkog modela postavljene su u skladu s prijašnjim istraživanjima i postavkama ekološkog modela razvoja ljudskog ponašanja (Bronfenbrenner, 1986; Swearer i Espelage, 2004). Na individualnoj razini to su spol, dob, empatija i impulzivnost. Na razini mikrosustava mjerena su tri mikrosustava koja su se pokazala značajna za razvoj djeteta. Bitno je naglasiti da bi možda neke varijable mikrosustava mogle biti svrstane i na druge razine (npr. školski uspjeh na individualnu razinu ili školska klima na razinu egzosustava). Međutim, u originalnom Bronfenbrennerovom radu (1986) mikrosustav uključuje neposredan kontekst u kojem se dijete nalazi (npr. obitelj i škola), veze između djeteta i bliskih ljudi (roditelja, prijatelja, nastavnika), ali i uloge koje dijete

ima unutar konteksta (npr. učenik i prijatelj). Stoga smo smatrali da odabrane varijable na razini mikrosustava najbolje reprezentiraju kontekst s kojim je dijete u neposrednoj vezi. Na razini mezosustava pokušali smo obuhvatiti interakcije dva mikrosustava, obiteljskog i školskog, i to putem dvije varijable: dolasci roditelja u školu (mjerena na razrednoj razini) te nejednakost obiteljskih prihoda unutar razreda kojeg učenik pohađa (također mjerena na razrednoj razini). Na razini egzosustava mjerili smo varijable za koje smo pretpostavili da imaju posredan utjecaj (preko mikrosustava) na dijete, a to su djetetova percepcija opasnosti susjedstva i količina vremena koju dijete provede uz medije.

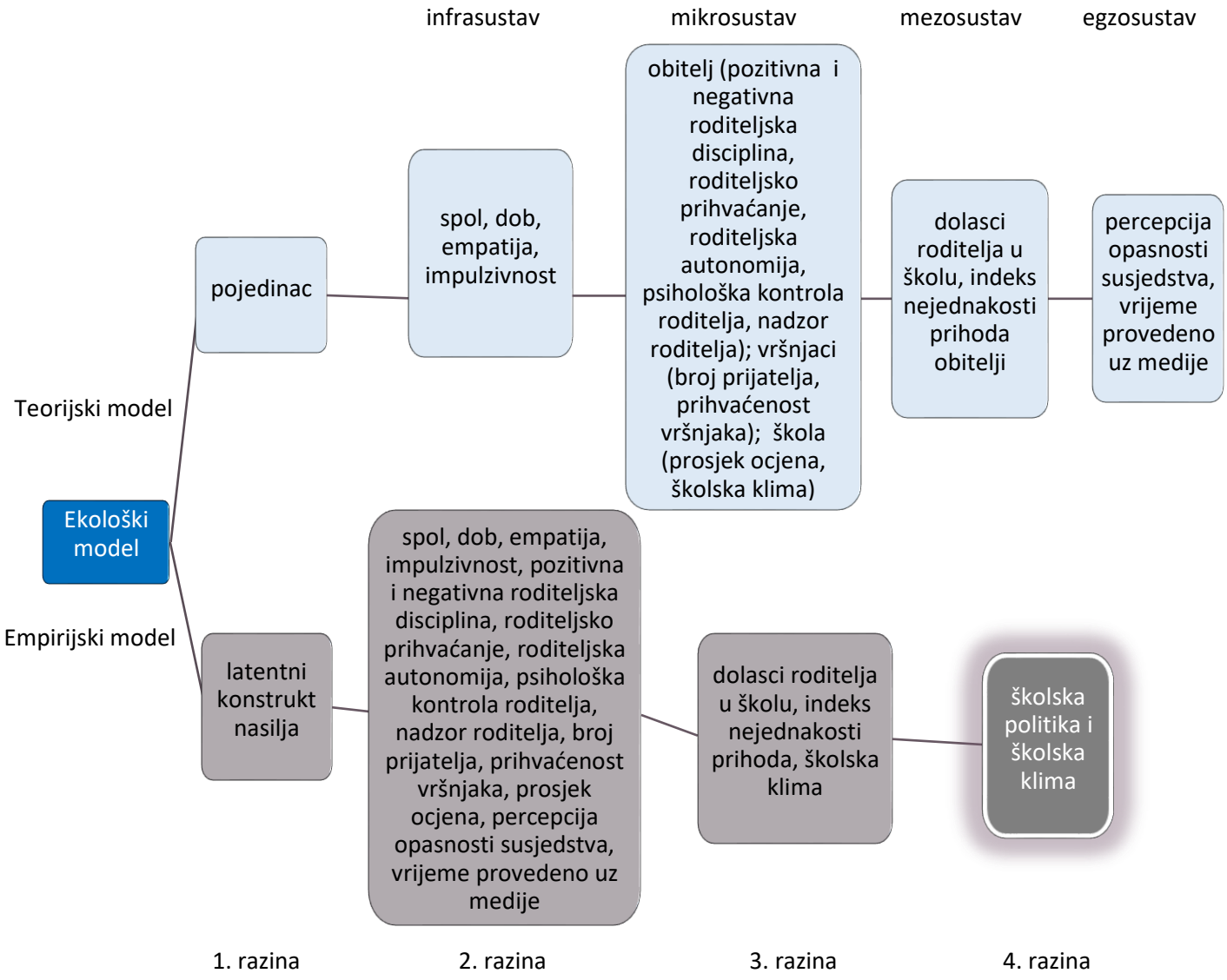
Idealno bi bilo kada bi se ova dva modela (empirijski i teorijski) u potpunosti slagala, odnosno kada bi sve razine i pretpostavljeni međusobni odnosi i interakcije u teorijskom modelu bile iste onima u empirijskom modelu. Međutim, često je gotovo nemoguće složeno ljudsko ponašanje empirijski ispitati, a posebice kada se radi o udaljenijim sustavima i mogućim interakcijama različitih razina (dodatne komplikacije stvara porast broja razina sustava i broja varijabli jer se povećava i broj mogućih interakcija). Granice između sustava često nisu jasno definirane, pa stoga nije niti moguće sve pretpostavljene varijable jednostavno i jednoznačno svrstati na određenu razinu. Iz tog razloga dolazi do zbrke i miješanja teorijski pretpostavljenog modela (kojeg je nemoguće u potpunosti empirijski prikazati i testirati) i empirijskog (statističkog) modela (koji je pojednostavljeni prikaz teorijskog modela kako bismo uopće mogli testirati određene teorijske postavke). Slika3 pokazuje oba modela, teorijski i empirijski, te raspored varijabli našeg istraživanja na pripadajućim razinama (razinama ekološkog modela i razinama mjerenja, odnosno empirijskog modela).

4.1. OPIS PRIMJERA MULTIVARIJATNOG VIŠERAZINSKOG MODELIRANJA

Za demonstraciju provođenja multivarijatnog višerazinskog modeliranja uzet ćemo primjer nasilnog ponašanja djevojčica (N=443, prosječne dobi 12,7 godina). U tom primjeru ishodišna (kriterijska varijabla) je multivarijatna i sastoji se od tri vrsta procjena koje smo prethodno opisali.

Provjeravat ćemo značajnost prediktora s druge i treće razine modela (kao što su prikazani u tablici 1.) te potencijalne interakcije na 2. razini modela, kao i provjeriti ima li značajnih interakcijskih efekata između 2. i 3. razine modela.

Kako bi lakše predočili razliku između teorijskog modela (u našem slučaju to je Bronfenbrennerov ekološki model koji opisuje ponašanje pojedinca kroz niz sustav koji ga okružuju i djeluju na njega poput koncentričnih kružnica) i empirijskog modela prikazat ćemo ih grafički (slika 3).



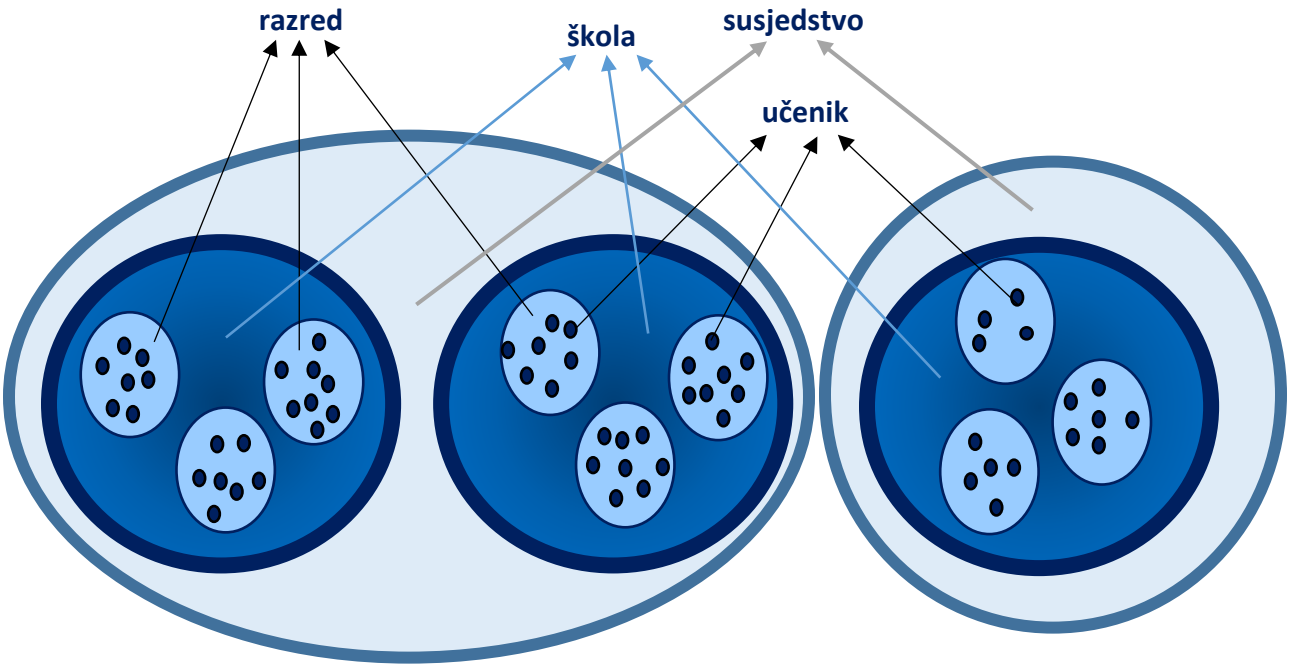
Slika 3. Prikaz teorijskog i empirijskog modela

Uspoređujući ova dva modela zamjećujemo da je prema teorijskom modelu pojedinac određen svojim individualnim karakteristikama (npr. spol, dob, empatija; što predstavlja infrasustav), njegova najbliža okolina su obitelj, vršnjaci i škola (mikrosustav), interakcije njegove najbliže okoline tvore mezosustav (npr. roditeljski sastanci u školi su interakcija obiteljskog i školskog mikrosustava) dok egzosustav predstavlja udaljeniji socijalni kontekst koji ne djeluje neposredno na dijete već preko njegova mikrosustava i infrasustava (kao što je susjedstvo u kojem dijete živi).

Kako bismo mogli provesti testiranje ovog modela potrebno ga je pojednostaviti i rasporediti teorijske varijable na mjernu razinu. U tu svrhu koristimo tzv. ugniježdene modele (*eng. nested models*). Promatrajući naš primjer to bi značilo da svatko dijete ide u jedan razred, svaki je razred

dio jedne škole, a svaka škola pripada određenom susjedstvu (slika 4). Dakle imamo hijerarhijsku organizaciju.

Kod provođenja istraživanja većinu varijablu prikupljamo na individualnoj razini, odnosno procjene nam daje samo dijete ili njegovi roditelji, vršnjaci i učitelji. Kako nam prva razina empirijskog modela predstavlja kriterijsku varijablu (nasilno ponašanje djevojčica) onda na drugoj razini modela definiramo potencijalne prediktore koje smo prikupili individualno (znači za svako dijete svaka se procjena razlikuje). Uspoređujući s teorijskim modelom to su varijable infrasustava, mikrosustava pa čak i egzosustava. Na trećoj razini modela definiramo varijable koje su prikupljene na grupnoj razini, odnosno na razini razreda. Znači sva djeca koja pohađaju isti razred imat će iste procjene ovih varijabli. Na teorijskoj razini to su varijable mezosustava (prosječni dolasci roditelja u školu za određeni razred, nejednakost prihoda unutar razreda, prosječna školska klima unutar razreda). Na četvrtoj razini modela definiraju se varijable na razini škole, odnosno za ove varijable djeca koja pohađaju istu školu imat će iste procjene (npr. školska politika o kažnjavanju nasilja unutar neke škole bit će ista za sve učenike koji pohađaju tu školu ili prosječna školska klima procijenjena od strane nastavnika neke škole jednaka je za svu djecu u toj školi). Da smo ispitivali npr. razinu zločina u susjedstvu u kojem se nalaze škole u istraživanju (npr. policijske evidencije zločina za pojedine dijelove grada) mogli bi imati varijablu i na petoj razini modela koja bi bila jednaka za sve učenike koje pohađaju sve škole koje se nalaze u određenom susjedstvu (slika 4).



Slika 4. Prikaz ugniježdenog modela

4.2. PITANJA NA KOJA ĆEMO ODGOVORITI PROVOĐENJEM MULTIVARIJATNOG VIŠERAZINSKOG MODELIRANJA

1. Koji su značajni individualni, obiteljski, školski i vršnjački prediktori (druga razina) u predviđanju nasilnog ponašanja kod djevojčica (korak 2)?
2. Koji prediktori s treće razine utječu na ukupnu količinu nasilja između razreda, nakon što kontroliramo prediktore s druge razine (korak 2)?
3. Postoje li značajne interakcije između varijabli na drugoj razini, odnosno interakcije između utjecaja medija i roditeljskog nadzora, te impulzivnosti i roditeljskog nadzora (korak 3 i korak 7)?
4. Da li regresijski koeficijenti između značajnih varijabli s druge razine i ukupnog nasilnog ponašanja djevojčica variraju između razreda (variraju na trećoj razini- korak 4)?
5. Ukoliko imamo variranje varijabli s druge razine između razreda, moderiraju li značajni prediktori s 3 razine modela (povećavaju ili smanjuju) utjecaj varijabli s druge razine na ukupno nasilje (korak 5 i korak 7)?

5. KORACI U PROVOĐENJU MULTIVARIJATNOG VIŠERAZINSKOG MODELIRANJA

Izračun za multivarijatno višerazinsko modeliranje proći ćemo kroz statistički program SPSS (*eng. Statistical Package for the Social Sciences*) s obzirom da je on jedan od najčešćih programa koji se koristi za analize podataka u društvenim znanostima te ne zahtjeva od korisnika poznavanje nekog od postojećih programskih jezika što ga čini vrlo pristupačnim. Tablice će biti prikazane na onaj način na koji ih i sam program prikazuje (s naznakom kada je potrebno nešto samostalno dodatno izračunati), kako bi čitatelju bilo razumljivije i lakše pratiti prema koracima cijeli postupak izračuna, odnosno kako bi ga u konačnici i sam mogao ponoviti na vlastitim podacima. U prilogu skripte dana su dva primjera kako se podaci multivarijatnog višerazinskog modeliranja, dobiveni u SPSS-u, tablično i grafički prikazuju pri objavi u časopisu (koji najčešće zahtijevaju tablične i grafičke prikaze prema APA (Američko psihološko udruženje) standardima), pri čemu se ti prikazi ponešto razlikuju od tabličnih prikaza koje dobivamo u SPSS-u.

5.1. SPECIFIKACIJA „NULL“ MODELA ILI TZV. PRAZNOG MODELA, ODNOSNO MODELA U KOJEM NEMA PREDIKTORSKIH VARIJABLI

U prvom koraku potrebno je specificirati model bez prediktora kako bismo provjerili varijance za svaku predviđenu razinu. Parcijalizacijom varijance kriterija na varijancu unutar grupe (klastera, razreda, varijanca između pojedinaca) i varijancu između grupe (između klastera, odnosno između razreda) možemo vidjeti svaku pojedinu varijaciju. Uobičajeno je pravilo ako je varijacija između grupa jako malo (manja od 5 %) da je nepotrebno uvoditi višerazinsko modeliranje jer se sva varijanca nalazi na individualnoj razini i tada možemo koristiti regresijsku analizu. Na temelju procjena varijanci možemo izračunati korelaciju unutar razina ICC (*eng. intraclass correlation*), što je zapravo mjera zavisnosti rezultata. ICC predstavlja proporciju ukupnog varijabiliteta kriterijske varijable za određenu razinu. Ukoliko je ICC velik znači da na toj razini postoji velika varijacija i da je svakako trebamo uvrstiti u model. Također Wald Z test nam govori o varijanci na određenoj razini. Ukoliko je Wald Z značajan znači da na toj razini postoji varijanca koju trebamo objasniti uvođenjem prediktorskih varijabli za tu razinu.

Tablica 2. Prikaz procjena varijabiliteta praznog modela za različite razine modela

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	DODATNO IZRAČUNAMO ICC	DODATNO IZRAČUNAMO OBJAŠNJENJE
Residual		.466760 σ^2_{level0}	.024885	18.757	.000	66.19%	varijabilnost nasilja, odnosi se na individualne razlike u procjeni i samoprocjeni nasilja na različitim upitnicima (unutar-grupna varijanca)
Intercept [subject = id2oznaka_razreda]	Variance	.046943 σ^2_{level2}	.018850	2.490	.013	6.66%	varijanca između razreda (razina razreda)
Intercept [subject = id3skola]	Variance	.000000[b] σ^2_{level3}	.000000	.	.	0%	varijanca između škola je 0 (nema varijacije)
Intercept [subject = id2oznaka_razreda * red_br]	Variance	.191446 σ^2_{level1}	.028475	6.723	.000	27.15%	varijanca unutar razreda odnosno između pojedinaca (razina učenika)

a. Dependent Variable: Zscore: ukupno nasilje - kombinacija svih kriterija.

b. This covariance parameter is redundant. The test statistic and confidence interval cannot be computed.

U tablici 2 prikazane su varijance za različite razine modela. U fusnoti (označeno slovom „a“) navedena je kriterijska varijabla za koju se promatra variranje kroz razine modela. U navedenom primjeru radi se o varijabli nasilnog ponašanja djevojčica koja je kombinacija tri različite mjere nasilnog ponašanja prethodno opisane u tekstu (kriterijske varijable na 1. razini modela iz tablice 1). Kako imamo više razina modela (učenici, razredi, škole) važno je kreirati varijablu koja će biti poveznica između različitih razina. Npr. redni broj (oznaka red_br) u novo strukturiranim podacima bit će poveznica za sva tri kriterija, odnosno tri reda horizontalnih podataka imat će isti redni broj koji će označavati da se ti podaci odnose na jednog te istog učenika (N=443). U navedenom primjeru potrebne su još dvije nove varijable koje će označavati poveznicu između učenika i razreda (oznaka id2oznaka_razreda), što će značiti da se svi učenici koji pohađaju isti razred označavaju jednako unutar te nove varijable (raspon ove varijable jednak je broju razreda uključenih u istraživanje, u navedenom slučaju N=58) te poveznicu između razreda i škola (oznaka id3skola) što će značiti da se svi razredi unutar jedne škole označavaju jednako (raspon ove varijable jednak je broju škola uključenih u istraživanje, N=6).

Kako bismo provjerili variranje nasilnog ponašanja na sve tri razine modela koristili smo sljedeću formulu (SPSS nema opciju automatski dati ove rezultate stoga ih je potrebno dodatno izračunati):

$\rho = \sigma^2_{level1} / (\sigma^2_{level1} + \sigma^2_{level2} + \sigma^2_{level3} + \sigma^2_{level0})$ odnosno

ICC = varijanca između grupa/ (varijanca između svih grupa + varijanca unutar grupa)

gdje σ^2 predstavlja varijancu, $level_1$ do $level_n$ označava razinu između grupa (variranje nasilja između učenika (level1), variranje nasilja između razreda (lelvel2) i variranje nasilja između škola (level3)), a $level_0$ se odnosi na varijancu unutar grupe (individualne razlike u procjeni i samoprocjeni nasilja na različitim upitnicima).

Prema tome (podaci iz tablice 2)

ICC (učenik) = 0,191446 / (0,191446 + 0,046943 + 0,000000 + 0,466760) = 0,27149 = 27,15%

ICC (razred) = 0,046943 / (0,191446 + 0,046943 + 0,000000 + 0,466760) = 0,06657 = 6,66%

ICC (škola) = 0,000000 / (0,191446 + 0,046943 + 0,000000 + 0,466760) = 0 = 0%

U navedenom primjeru možemo vidjeti da je značajno variranje na individualnoj razini (27,15%) i na razini razreda (6,66%) što nam potvrđuje i testiranje statističke značajnosti (Wald Z je statistički značajan, $p<0.05$). Varijanca između razreda je 6,66% što znači da je potrebno provesti višerazinsko modeliranje jer i ova varijanca značajno doprinosi objašnjenju modela.

Na razini škole (imali smo 6 škola za koje smo promatrali razlikuju li se značajno u varijabilitetu nasilnog ponašanja) nije dobiveno značajno variranje. Varijanca je 0%, a Wald Z se niti ne može izračunati za nultu varijancu. U navedenom primjeru to bi značilo da je jednako variranje vršnjačkog nasilja djevojčica u školama koje smo obuhvatili istraživanjem, odnosno da se te škole ne razlikuju s obzirom na procjenu nasilja te da nema potrebe za uvođenjem razine škole u model jer nam ona ne bi doprinijela nikakvom novom objašnjenju variranja nasilnog ponašanja djevojčica.

Kod definiranja ovog modela potrebno je odabrati i strukturu matrice kovarijance na temelju koje će se provoditi analiza. Matrica identiteta (*eng. scale identity* - ID) se koristi kada imamo samo jedan varirajući efekt (*eng. random effect*), što je uglavnom slučaj samo kod praznog modela dok je za ostale modele situacija složenija. Kovarijanca strukture koja je dosta jednostavna i pretpostavlja da su svi slučajni efekti nezavisni je varijanca komponente (VC, *eng. variance components*). Ona se najčešće koristi kod složenijih modela te smo je i mi primijenili u svojoj analizi. Slična njoj je i dijagonalna matrica (DIAG), ali se češće koristi kod ponovljenih mjerenja. Nestrukturirana matrica (UN) se može koristiti ukoliko nemamo upozorenja od samog programa da nije moguće provesti analizu zbog prevelike složenosti modela. Ona procjenjuje dodatne interakcije, ali ju je nemoguće odabrati za puno modela, pogotovo složenijih. Kada imamo veći

broj prediktora (kao u našem slučaju) program ne može izračunati sve moguće parametre s ovom matricom pa se onda umjesto nje koristi VC matrica (koju smo i mi primijenili).

I na posljetku potrebno je odabrati metodu procjene na temelju koje će se vršiti analiza. U SPSS-u je moguće odabrati 2 metode: ML (*eng. maximum likelihood*) i REML (*eng. restricted maximum likelihood*). REML se obično koristi kod malog broja grupa i manjeg uzorka i obično daje predikcije koje su sličnije realnosti. U REML-u samo su komponente varijance uključene u funkciji sličnosti (*eng. likelihood function*). ML daje optimalnu vrijednost populacije za parametre u modelu koja maksimizira vjerojatnost funkcije sličnosti (*eng. likelihood function*), a uključuje regresijske koeficijente i komponente varijance u funkciju sličnosti. ML se obično koristi kod dovoljno velikog uzorka i u tom slučaju daje jednako dobro predikcije kao i REML. Također se ova metoda primjenjuje kada imamo ugniježdene modele, i kada su oni složeniji. Na temelju ML možemo raditi usporedbe više modela dok kod REML-a to nije moguće. Zbog velikog uzorka (u psihologijskim istraživanjima sve iznad N=300 sudionika smatra se velikim uzorkom), ugniježdenih i složenih modela te zbog mogućnosti usporedbe više modela u našoj analizi koristili smo ML metodu procjene

5.2. UVOĐENJE PREDIKTORSKIH VARIJABLI

U drugom koraku, nakon što smo odredili koliko će razina imati model, uvodimo potencijalne prediktore za obje razine i određujemo koji su prediktori značajni na drugoj razini i koji su značajni na trećoj razini (uz kontrolu druge). Bitno je naglasiti da se značajnost prediktora (odnosno regresijskih koeficijenata) testira dvosmjerno. Međutim, kako mi imamo određene teorijske pretpostavke o smjeru djelovanja potrebno je jednosmjerno testiranje što znači da zapravo uzimamo u obzir sve prediktore kojima je $p<0,10$ ($0,10/2 = 0,05$).

Tablica 3. Procjene značajnosti svih prediktora

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.
Intercept	-.047124	.035329	58.667	-1.334	.187
dob	-.026959	.034498	119.215	-.781	.436
ocjene	-.042202	.034448	432.498	-1.225	.221
empatija	.005007	.049634	407.556	.101	.920
vrijeme uz medije	.067117	.036325	415.373	1.848	.065
impulzivnost	.330923	.038199	414.249	8.663	.000
broj prijatelja	-.013640	.034282	411.280	-.398	.691
prihvaćenost vršnjaka	-.021542	.058265	429.076	-.370	.712
pozitivna roditeljska disciplina	.044281	.061312	407.367	.722	.471
negativna roditeljska disciplina	.049887	.049846	410.764	1.001	.318
roditeljsko prihvaćanje	-.142238	.077921	406.127	-1.825	.069
roditeljska autonomija	.076323	.085400	399.944	.894	.372
psihološka kontrola roditelja	.007154	.046505	411.124	.154	.878
roditeljski nadzor	-.051100	.056066	419.526	-.911	.363
opasnost susjedstva	-.163356	.043089	427.508	-3.791	.000
školska klima u razredu	-.032361	.091750	60.464	-.353	.726
dolasci roditelja u školu	.262691	.117962	43.568	2.227	.031
nejednakost prihoda u razredu	.796223	1.301393	59.127	.612	.543

a. Dependent Variable: Zscore: ukupno nasilje - kombinacija svih kriterija.

U našem primjeru značajni su sljedeći prediktori na drugoj razini: vrijeme provedeno uz medije (p=0,0325), impulzivnost (p=0,00), roditeljsko prihvaćanje (p=0,0345) i opasnost susjedstva (p=0,00). Na trećoj razini značajan je samo jedan prediktor, dolasci roditelja u školu (p=0,0155).

Također sada možemo provjeriti i koliko se varijanca smanjila nakon što smo uveli prediktore, je li ostalo još značajne varijance na nekoj razini koju treba objasniti i koliko smo varijance uspjeli objasniti na svakoj razini (tablica 4).

Tablica 4. Prikaz procjena varijabiliteta prediktorskog modela za različite razine modela

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	DODATNO IZRAČUNAMO		
						ICC ostalo za objasniti	smanjenje varijance	objašnjena varijanca R^2
Residual		.434684	.023026	18.878	.000	ostaje isto, ništa ne računamo		
Intercept [subject = id2oznaka_razreda]	Variance	.023939	.012364	1.936	.053	4.24%	6.66 – 4.24 = 2.42%	49.00% varijance između razreda je objašnjeno prediktorima s treće razine
Intercept [subject = id2oznaka_razreda * red_br]	Variance	.105349	.021091	4.995	.000	18.68 %	27.15-18.68= 8.47%	44.97% varijance unutar razreda, odnosno između pojedinaca objašnjeno je prediktorima s druge razine

a. Dependent Variable: Zscore: ukupno nasilje - kombinacija svih kriterija.

Varijancu koja je ostala za objasniti na svakoj razini (ICC) računamo jednako kao u prethodnim primjeru u kojem smo računali intraklasne koeficijente korelacije (tablica 2), prema istoj formuli:

ICC = varijanca između grupa/ (varijanca između svih grupa + varijanca unutar grupa)

$ICC\ (učenik)_{preditorski\_model} = 0{,}023939 / (0{,}434684 + 0{,}023939 + 0{,}105349) = 0{,}424 = 4.24\%$

$ICC\ (razred)_{prediktorski\_model} = 0{,}105349 / (0{,}434684 + 0{,}023939 + 0{,}105349) = 0{,}1868 = 18{,}68\%$

Kako bismo izračunali za koliko se varijanca smanjila na svakoj razini modela oduzet ćemo intraklasne koeficijente korelacije koje smo dobili u drugom prediktorskom modelu (tablica 4) od intraklasnih koeficijenta korelacije koje smo izračunali za prvi prazni model (tablica 2):

$Objašnjenja\ varijanca = ICC_{null\_model} - ICC_{preditorski\_model}$

Objašnjena varijanca na razini učenika = 6,66 – 4,24 = 2,42%

Objašnjena varijanca na razini razreda = 27,15 – 18,68 = 8,47%

Osim toga, za interpretaciju je korisno izračunati koliko smo varijance uspjeli objasniti na svakoj razini modela (R^2) uvođenjem prediktorskih varijabli. To možemo izračunati prema sljedećoj formuli:

$R^2 = (\sigma^2_{M1} - \sigma^2_{M2}) / \sigma^2_{M1}$

gdje σ^2 predstavlja varijancu, M1 označava određenu razinu (level) za null model (tablica 2), a M2 istu razinu (level), ali za prediktorski model (tablica 4).

R^2 razina učenika = (0,191446 – 0,105349) / 0,191446 = 0,4497 = 44,97%

R^2 razina razreda = (0,046943 – 0,023939) / 0,046943 = 0,4900 = 49,00%

Na našem primjeru možemo vidjeti da smo na razini razreda uspjeli objasniti 49% varijance te razine pomoću prediktora koje smo uveli (dolasci roditelja u školu). Također na trećoj razini je ostalo za objasniti još 4,24 % ukupne varijance koja nije značajna (Wald Z nije značajan) što bi značilo da nema potrebe za uvođenjem novih prediktora na ovoj razini. Smanjenje varijance na trećoj razini je za 2,42% nakon uvođenja prediktora.

Na razini učenika došlo je do smanjenja varijance za 8,47% nakon uvođenja prediktora. Ostalo je za objasniti 18,68% varijance na ovoj razini što je i statistički značajno (Wald Z je značajan), što znači da je potrebno uvesti dodatne prediktore kako bismo objasnili ove varijacije. Na razini učenika ukupno smo uspjeli objasniti 44,97% varijance unutar razreda (između pojedinaca) pomoću uvedenih prediktora (vrijeme provedeno uz medije, impulzivnost, roditeljsko prihvaćanje i opasnost susjedstva).

5.3. UVOĐENJE INTERAKCIJA NA DRUGOJ RAZINI

U našem primjeru pretpostavili smo da postoje interakcije na drugoj razini i to između vremena provedenog uz medije i roditeljskog nadzora, te između impulzivnosti i roditeljskog nadzora. Međutim kako varijabla roditeljski nadzor nije bila statistički značajna na drugoj razini nije imalo smisla provjeravati značajnost pretpostavljenih interakcija. Ukoliko želimo provjeravati interakcijski efekt dvije varijable preduvjet je da obje varijable budu statistički značajni prediktori.

5.4. PROVJERA VARIRANJA ZNAČAJNIH PREDIKTORA S DRUGE RAZINE NA TREĆOJ RAZINI

Idući korak je provjeriti da li neki od značajnih prediktora na drugoj razini (unutar razreda) variraju i na trećoj razini, odnosno značajno variraju i između razreda. Ukoliko značajno variraju znači da možemo provjeriti interakcije varijabli s druge i treće razine. Samo za one prediktore koji su značajni na drugoj razini možemo provjeravati da li značajno variraju i na trećoj razini.

Za navedeni primjer (tablica 5) možemo vidjeti da su tri prediktora individualne razine značajno varirala i na razrednoj razini (vrijeme uz medije, impulzivnost i opasnost susjedstva, p<0,10; 0,10/2 = 0,05).

Tablica 5. Prikaz variranja prediktora druge razine modela na trećoj razini modela (između razreda)

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.
Residual		.433035	.022877	18.929	.000
Intercept [subject = id2oznaka_razreda]	Variance	.017738	.011028	1.609	.108
vrijeme uz medije [subject = id2oznaka_razreda]	Variance	.031537	.016875	1.869	.062
impulzivnost [subject = id2oznaka_razreda]	Variance	.031661	.018128	1.747	.081
roditeljsko prihvaćanje [subject = id2oznaka_razreda]	Variance	.055195	.032811	1.682	.093
opasnost susjedstva [subject = id2oznaka_razreda]	Variance	.029185	.018250	1.599	.110
Intercept [subject = id2oznaka_razreda * Rid3]	Variance	.029901	.018559	1.611	.107

a. Dependent Variable: Zscore: ukupno nasilje - kombinacija svih kriterija.

5.5. UVOĐENJE INTERAKCIJA IZMEĐU DRUGE I TREĆE RAZINE

Kako je u prethodnom koraku bilo značajnih varijacija varijabli s druge na trećoj razini uveli smo interakcije između druge razine (impulzivnost, vrijeme provedeno uz medije i opasnost susjedstva) i treće razine (dolasci roditelja u školi). Na ovaj način provjerili smo da li postoji moderatorski utjecaj dolazaka roditelja u školu na sljedeće veze: impulzivnost – ukupno nasilno ponašanje djevojčica, vrijeme provedeno uz medije - ukupno nasilno ponašanje djevojčica te opasnost susjedstva - ukupno nasilno ponašanje djevojčica.

Iz tablice 6 možemo očitati da postoji samo jedna značajna interakcija odnosno moderatorski utjecaj. Moderatorski utjecaj dolazaka roditelja u školu značajan je samo za vezu impulzivnost i ukupno nasilno ponašanje djevojčica.

Tablica 6. Prikaz značajnosti interakcija između druge i treće razine modela

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	61.550	1.604	.210
dob	1	122.933	.669	.415
ocjene	1	433.243	1.328	.250
empatija	1	408.183	.018	.894
vrijeme uz medije	1	421.587	3.101	.079
impulzivnost	1	415.792	72.303	.000
broj prijatelja	1	410.239	.463	.496
prihvaćenost vršnjaka	1	429.176	.312	.577
pozitivna roditeljska disciplina	1	407.326	.069	.793
negativna roditeljska disciplina	1	411.843	1.162	.282
roditeljsko prihvaćanje	1	407.544	3.612	.058
roditeljska autonomija	1	401.789	1.799	.181
psihološka kontrola roditelja	1	411.409	.095	.759
roditeljski nadzor	1	421.547	1.519	.218
opasnost susjedstva	1	427.638	13.763	.000
školska klima u razredu	1	62.397	.110	.741
dolasci roditelja u školu	1	45.316	5.410	.025
nejednakost prihoda u razredu	1	62.731	.319	.574
impulzivnost * dolasci roditelja u školu	1	384.622	10.972	.001
vrijeme uz medije * dolasci roditelja u školu	1	388.025	.093	.761
roditeljsko prihvaćanje * dolasci roditelja u školu	1	380.217	1.033	.310

a. Dependent Variable: Zscore: ukupno nasilje - kombinacija svih kriterija.

5.6. USPOREDBA DOBIVENIH MODELA NA TEMELJU RAZLIČITIH KRITERIJA

Kako bismo se odlučili koji od ugniježdenih modela odabiremo kao konačni trebamo promotriti određene kriterije. Bitno je naglasiti da je cilj da model bude što parsimoničniji. U ovom slučaju neće konačni model biti onaj prikazan u tablici 6, jer ima dvije neznačajne interakcije koje nam samo oduzimaju stupnjeve slobode. Stoga ćemo neznačajne interakcije izbaciti i kao konačni model odabrati prediktorski model prikazan u tablici 7.

Tablica 7. Prikaz konačnog prediktorskog modela objašnjenja nasilnog ponašanja djevojčica

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.
Intercept	-.041318	.034806	60.212	-1.187	.240
dob	-.026103	.033998	120.458	-.768	.444
ocjene	-.038583	.034079	433.220	-1.132	.258
empatija	-.007437	.049222	408.573	-.151	.880
vrijeme uz medije	.064725	.035919	416.021	1.802	.072
impulzivnost	.325463	.037809	415.027	8.608	.000
broj prijatelja	-.023681	.034014	410.871	-.696	.487
prihvaćenost vršnjaka	-.034809	.057759	429.219	-.603	.547
pozitivna roditeljska disciplina	.016210	.061201	407.496	.265	.791
negativna roditeljska disciplina	.054590	.049307	411.415	1.107	.269
roditeljsko prihvaćanje	-.146486	.077047	406.890	-1.901	.058
roditeljska autonomija	.108092	.084977	402.448	1.272	.204
psihološka kontrola roditelja	.012877	.046014	411.806	.280	.780
roditeljski nadzor	-.067531	.055667	421.616	-1.213	.226
opasnost susjedstva	-.158012	.042635	427.483	-3.706	.000
školska klima u razredu	-.027458	.090290	61.477	-.304	.762
dolasci roditelja u školu	.277053	.116013	44.499	2.388	.021
nejednakost prihoda u razredu	.797273	1.280635	60.292	.623	.536
impulzivnost * dolasci roditelja u školu	.388604	.118565	386.604	3.278	.001

a. Dependent Variable: Zscore: ukupno nasilje - kombinacija svih kriterija.

U ovom koraku odabiremo parsimoničniji model na temelju različitih kriterija. Općenito vrijedi da je bolje da su vrijednosti kriterija niže. Uspoređujemo kriterije pristajanja prvog prediktorskog modela (tablica 8) s kriterijima pristajanja konačnog prediktorskog modela (tablica 9).

Tablica 8. Kriteriji pristajanja prvog prediktorskog modela

Information Criteria[a]

-2 Log Likelihood	2434.295
Akaike's Information Criterion (AIC)	2476.295
Hurvich and Tsai's Criterion (AICC)	2477.147
Bozdogan's Criterion (CAIC)	2602.493
Schwarz's Bayesian Criterion (BIC)	2581.493

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Zscore: ukupno nasilje - kombinacija svih kriterija.

Tablica 9. Kriteriji pristajanja konačnog prediktorskog modela

Information Criteria[a]

-2 Log Likelihood	2423.667
Akaike's Information Criterion (AIC)	2467.667
Hurvich and Tsai's Criterion (AICC)	2468.601
Bozdogan's Criterion (CAIC)	2599.874
Schwarz's Bayesian Criterion (BIC)	2577.874

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Zscore: ukupno nasilje - kombinacija svih kriterija.

Nekoliko različitih kriterija možemo promatrati ovisno o broju parametara koje procjenjujemo, odnosno kompleksnosti modela te o veličini uzorka.

AIC (Akaike's information criteria) je mjera stupnjeva slaganja koja ima korekciju vezanu uz kompleksnost modela, odnosno uzima u obzir koliko je parametara u modelu procijenjeno. Kako je u našem primjeru kompleksan model testiran (puno prediktora i interakcija) te je bio velik uzorak (N=433) ovaj kriterij bio trebao biti glavni prema kojem odlučujemo.

AICC (Hurvich and Tsai's Criterion) isto što i AIC, ali za male uzorke.

CAIC (Bozdogan's Criterion) isto kao i AIC, ali je korekcija izvršena ne samo za kompleksnost modela nego i za veličinu uzorka.

BIC (Schwarz's Bayesian Criterion) slično ako i AIC, ali je malo konzervativnija (stroža korekcija za broj parametara koji se procjenjuju). Treba se koristiti kada je velik uzorak i mali broj parametara.

U našem primjeru manje su vrijednosti kriterija za model s uključenom interakcijom što znači da bi njega trebali ostaviti kao konačni model.

Ukupno pristajanje višerazinskog modela možemo testirati i pomoću hi-kvadrat testa omjera sličnosti (χ^2 likelihood ratio test) na temelju izvještaja o vrijednostima -2 Log Likelihood (statistika odstupanja - indikator koliko sveukupni model dobro pristaje podacima). Kako bi odredili granične vrijednosti značajnosti hi-kvadrat distribucije potrebna je tablica kritičnih vrijednosti hi-kvadrat distribucije za određene stupnjeve slobode koja se nalazi u dodatku A.

Broj stupnjeva modela iščitavamo iz prve tablice koju nam program SPSS prikazuje, a radi se o tablici koja opisuje parametre modela (tablica 10 i tablica 11). Da bismo mogli izračunati značajnost pristajanja modela moramo izračunati i stupnjeve slobode.

Hi-kvadrat računamo prema sljedećoj formuli:

$\chi^2_{promjena}$ = (-2 Log Likelihood$_{početni}$) – (-2 Log Likelihood$_{konačni}$)

= 2434,295 – 2423,667 = 10,628

a broj stupnjeva slobode prema :

$SS_{promjena}$ = |broj parametara$_{početni}$ - broj parametara$_{konačni}$ |= |21 – 22| = 1 .

Broj parametara početnog prediktorskog modela vidimo u tablici 10, a broj parametara novog konačnog modela u tablici 11.

Tablica 10. Broj parametara početnog prediktorskog modela

Model Dimension[b]

		Number of Levels	Covariance Structure	Number of Parameters	Subject Variables
Fixed Effects	Intercept	1		1	
	dob	1		1	
	ocjene	1		1	
	empatija	1		1	
	vrijeme uz medije	1		1	
	impulzivnost	1		1	
	broj prijatelja	1		1	
	prihvaćenost vršnjaka	1		1	
	pozitivna roditeljska disciplina	1		1	
	negativna roditeljska disciplina	1		1	
	roditeljsko prihvaćanje	1		1	
	roditeljska autonomija	1		1	
	psihološka kontrola roditelja	1		1	
	roditeljski nadzor	1		1	
	opasnost susjedstva	1		1	
	školska klima u razredu	1		1	
	dolasci roditelja u školu	1		1	
	nejednakost prihoda u razredu	1		1	
Random Effects	Intercept[a]	1	Variance Components	1	id2oznaka_razreda
	Intercept[a]	1	Variance Components	1	id2oznaka_razreda * Rid3
Residual				1	
Total		20		21	

Tablica 11. Broj parametara konačnog prediktorskog modela

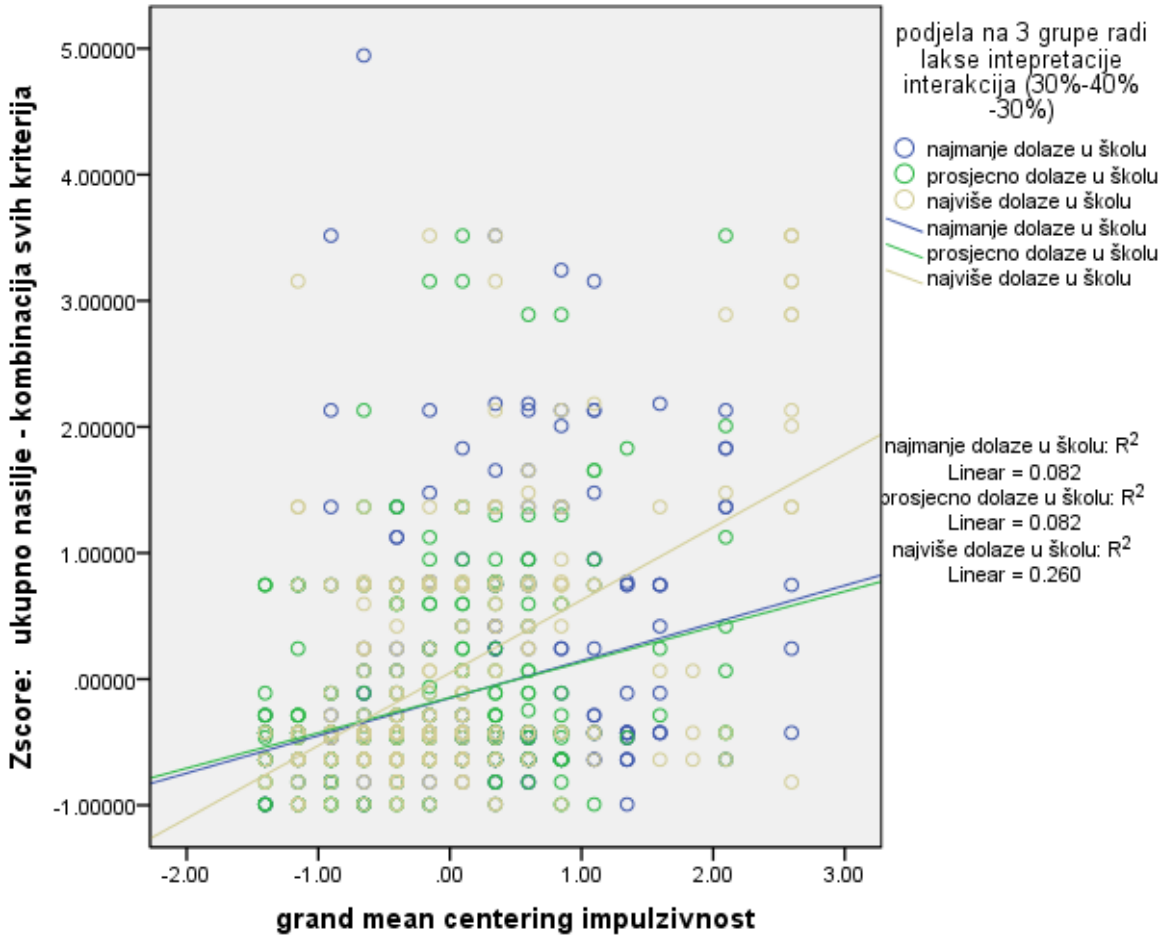
Model Dimension[b]

		Number of Levels	Covariance Structure	Number of Parameters	Subject Variables
Fixed Effects	Intercept	1		1	
	dob	1		1	
	ocjene	1		1	
	empatija	1		1	
	vrijeme uz medije	1		1	
	impulzivnost	1		1	
	broj prijatelja	1		1	
	prihvaćenost vršnjaka	1		1	
	pozitivna roditeljska disciplina	1		1	
	negativna roditeljska disciplina	1		1	
	roditeljsko prihvaćanje	1		1	
	roditeljska autonomija	1		1	
	psihološka kontrola roditelja	1		1	
	roditeljski nadzor	1		1	
	opasnost susjedstva	1		1	
	školska klima u razredu	1		1	
	dolasci roditelja u školu	1		1	
	nejednakost prihoda u razredu	1		1	
	impulzivnost * dolasci roditelja u školu	1		1	
Random Effects	Intercept[a]	1	Variance Components	1	id2oznaka_razreda
	Intercept[a]	1	Variance Components	1	id2oznaka_razreda * Rid3
Residual				1	
Total		21		22	

Na temelju tablice o kritičnim vrijednostima hi-kvadrat distribucije, kritična vrijednost za 1 stupanj slobode za p<0,01 je 6,63 (dodatak A). Kako je naša vrijednost veća (10,628) od granične vrijednosti znači da je dobiveno statistički značajno poboljšanje modela uvođenjem interakcije i da model s interakcijom treba ostaviti kao krajnji model.

5.7. CRTANJE INTERAKCIJE

Kako bismo objasnili interakcije i moderatorske utjecaje potrebno ih je nacrtati, inače nije moguća interpretacija. U tu svrhu morali smo kreirati novu varijablu. Varijablu dolasci roditelja u školu smo transformirali u novu varijablu tako da smo stvorili tri kategorije: roditelji koji slabo dolaze u školu, roditelji koji prosječno dolaze u školu i roditelji koji stalno dolaze u školu (30% - 40% - 30%) radi lakše interpretacije i crtanja grafova (slika 3).



Slika 3. Interakcija između impulzivnosti i dolazaka roditelja u školu za ukupno nasilno ponašanje djevojčica na 3. razini (između razreda)

Iz navedenog grafa možemo vidjeti moderatorski utjecaj roditeljskih dolazaka u školu na povezanost impulzivnosti s nasilnim ponašanjem djevojčica. U razredima gdje roditelji često (najviše) dolaze u školu jača je povezanost impulzivnosti s nasilnim ponašanjem (što može biti i razlog čestih roditeljskih dolazaka u taj razred), za razliku od razreda u kojima roditelji prosječno ili slabije dolaze gdje i dalje postoji povezanost impulzivnosti s nasilnim ponašanjem, ali je ta povezanost znatno slabija.

6. UMJESTO ZAKLJUČKA

S obzirom da smo prije prikaza koraka potrebnih za provođenje multivarijatnog višerazinskog modeliranja postavili konkretna pitanja sada ćemo na njih dati i sažete odgovore koji se mogu pronaći gore u tekstu u opisanim provedenim koracima.

ODGOVORI NA POSTAVLJENA PITANJA:

1. Koji su značajni individualni, obiteljski, školski i vršnjački prediktori (druga razina) u predviđanju nasilnog ponašanja kod djevojčica (korak 2)?

U našem primjeru značajni su sljedeći prediktori na drugoj razini: vrijeme provedeno uz medije (p=0,0325), impulzivnost (p=0,00), roditeljsko prihvaćanje (p=0,0345) i opasnost susjedstva (p=0,00).

2. Koji prediktori s treće razine utječu na ukupnu količinu nasilja između razreda, nakon što kontroliramo prediktore s druge razine (korak 2)?

Na trećoj razini značajan je samo jedan prediktor, dolasci roditelja u školu (p=0,0155).

3. Postoje li značajne interakcije između varijabli na drugoj razini, odnosno interakcije između utjecaja medija i roditeljskog nadzora, te impulzivnosti i roditeljskog nadzora (korak 3 i korak 7)?

Kako varijabla roditeljski nadzor nije bila statistički značajna na drugoj razini nije imalo smisla provjeravati značajnost pretpostavljenih interakcija. Dakle na drugoj razini modela nema značajnih interakcija.

4. Da li regresijski koeficijenti između značajnih varijabli s druge razine i ukupnog nasilnog ponašanja djevojčica variraju između razreda (variraju na trećoj razini- korak 4)?

Za navedeni primjer (tablica 5) možemo vidjeti da su tri prediktora individualne razine značajno varirala i na razrednoj razini (vrijeme uz medije, impulzivnost i opasnost susjedstva).

5. Ukoliko imamo variranje varijabli s druge razine između razreda, da li značajni prediktori s 3 razine moderiraju (povećavaju ili smanjuju) utjecaj varijabli s druge razine na ukupno nasilje (korak 5 i korak 7)?

Postoji moderatorski utjecaj dolazaka roditelja u školu na vezu impulzivnost-nasilje. U razredima gdje roditelji često (najviše) dolaze u školu veći je utjecaj impulzivnosti na nasilno ponašanje djevojčica, za razliku od razreda u kojima roditelji prosječno ili slabije dolaze gdje je taj utjecaj slabiji.

Sažeti prikaz dobivenih rezultata dan je u tablici 12. Znakom plus označeni su značajni prediktori i interakcije u konačnom modelu.

Tablica 12. Sažeti prikaz značajnosti svih potencijalnih prediktora za ukupno nasilno ponašanje djevojčica

	Nasilno ponašanje djevojčica
prediktori	
individualni (infrasustav)	
dob	-
afektivna empatija	-
impulzivnost	+
mikrosustav	
obitelj	
pozitivna roditeljska disciplina	-
negativna roditeljska disciplina	-
roditeljsko prihvaćanje	+
roditeljska autonomija	-
psihološka kontrola roditelja	-
nadzor roditelja	-
vršnjaci	
broj prijatelja	-
prihvaćenost vršnjaka	-
škola	
prosjek ocjena	-
školska klima	-
mezosustav	
dolasci roditelja u školu	+
indeks nejednakosti prihoda	-
egzosustav	
vrijeme uz medije	+
percepcija opasnosti susjedstva	+
interakcije infra i mezosustava	
impulzivnost x dolasci roditelja u školu	+

U prilogu A i B dani su primjeri objavljenih znanstvenih radova koji prikazuju istu analizu podatka. Radovi su prikazani kao primjeri dobre interpretacije i načina pisanja rezultata kada koristimo multivarijatno višerazinsko modeliranje kao glavnu analizu podatka.

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DODATAK A

TABLICA 15. KRITIČNE VRIJEDNOSTI HI-KVADRAT DISTRIBUCIJE

Stupnjevi slobode	Razine rizika (p)			Stupnjevi slobode	Razine rizika (p)		
	0.05	0.01	0.001		0.05	0.01	0.001
1	3.841	6.635	10.828	11	19.675	24.725	31.264
2	5.991	9.210	13.816	12	21.026	26.217	32.910
3	7.815	11.345	16.266	13	22.362	27.688	34.528
4	9.488	13.277	18.467	14	23.685	29.141	36.123
5	11.070	15.086	20.515	15	24.996	30.578	37.697
6	12.592	16.812	22.458	16	26.296	32.000	39.252
7	14.067	18.475	24.322	17	27.587	33.409	40.790
8	15.507	20.090	26.125	18	28.869	34.805	42.312
9	16.919	21.666	27.877	19	30.144	36.191	43.820
10	18.307	23.209	29.588	20	31.410	37.566	45.315

PRILOG 1. *

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CAN WE USE SAME PREDICTORS FOR BOYS VS GIRLS PEER AGGRESSION?[2]

Using the theoretical framework of Bronfenbrenner's ecological model of peer aggression, the aim of the present study was to examine if we could use the same predictors of peer aggression at schools for boys and girls. The research included 880 participants, elementary school students from the fifth to the eighth grade, who self-estimated aggressive behavior toward their peers, affective empathy, impulsivity, parental behavior, peer acceptance, a number of friends, exposure to media, school climate, perception of neighborhood dangerousness, and also nominated aggressive peers and gave data about the school achievement and a number of friends. The same number of their parents gave data about family SES, while 107 teachers estimated attendance of parents at the parent-teacher meetings and other school events. Multivariate multilevel modeling revealed different predictors of boys vs girls peer aggression. Selected predictors of ecological model better explained peer aggression in boys than in girls. The main differences were in individual characteristic and family microsystem, whereas more statistically significant predictors were for boys, while some distal predictors in an interaction with individual characteristics and family microsystem were important in the explanation of boys' aggressive behavior. The overall results indicate that gender, as a biological category, had a strong influence on peer aggression. Psychological characteristics, as well as parental upbringing, better explained boys' than girls' aggressive behavior. These findings are very important for the school policy, which means that the intervention and prevention programs for peer aggression should differ depending on the child's gender.

Key words: gender, ecological model, peer aggression, predictors

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Introduction

Gender as Predictor of Peer Aggression

Gender is probably the most examined individual characteristic of peer aggression. Almost all studies have shown that boys are more physically and verbally aggressive toward their peers (Espelage, Bosworth, & Simon, 2000). Olweus (2010) has shown that boys are more physically and verbally aggressive than girls, and furthermore, equally or even more aggressive when it comes to indirect and relational types of aggression, especially for the primary school children. Gender differences in verbal aggression decrease with age, while they stay throughout the adulthood for physical aggression. Data are not so clear for indirect and relational types of aggression, indicating more indirect aggression for girls in adolescence (Björkqvist, 2018; Dinić, Sokolovska, Milovanović, & Oljača, 2014; Olweus, 2010).

One of the most examined approaches is the social-ecological perspective, which takes account of reciprocal interplay among individuals involved in the peer aggression, and its complex contexts is Bronfenbrenners' ecological model (Bronfenbrenner, 1979; Espelage & Swearer, 2004; Olweus, 1998). The child (individual) is in the center of ecological model, with his/her own psychological, biological, and behavioral characteristics, which represent the infrasystem. Individual factors influence the way in which the child is involved in aggression: as a perpetrator or a victim (Espelage & Swearer, 2004). The child is surrounded with different contexts which he/she interacts in. The microsystem is the closest context and has a direct influence on the child's development. The microsystem usually includes the child's interaction with the family, peers and the school. Relations in the microsystem or the interaction between different microsystems (e.g., interaction of the family and the school system) make a mesosystem. The exosystem has a distal influence on the child's development, which refers to the indirect environmental influence on the child (e.g., community and neighborhood). The exosystem variable influences the child through his/her microsystem (e.g., influencing his/her family or the school). The most distal context is the macrosystem that refers to broader social context, like the culture and country policies (Slee & Shute, 2003). Applying ecological approach to the problem of peer aggression, numerous studies have shown that being a male is a significant predictor of peer aggression and bullying. For example, Kim, Orpinas, Kamphaus, and Kelder (2011) first tested influences of four risk domains (individual, family, community and media) on the development of peer aggression, and found that being a male was a statistically significant predictor of peer aggression. Lee (2011) tested all levels of the ecological model on American and Korean students, and showed for both groups of students that being a male was a good predictor of bullying. You, Kim, and Kim (2014) study on Korean secondary school students found that being a male was a significant predictor for verbal and physical bullying (You et al., 2014).

Furthermore, the same results were obtained for Taiwan students (Wei, Williams, Chen, & Chang, 2010), and also for Croatian students (Velki, 2018b).

However, studies that would examine a moderate role of gender in predicting peer aggression are lacking, especially in Europe. In Serbia, one study examined a moderate role of gender in the relationships between empathy and peer violence among adolescents (Dinić, Kodžopeljić, Sokolovska, & Milovanović, 2016), but starting point was not the ecological model of human behavior. Different cultural influences in Europe vs USA, especially in the traditional countries like Croatia (Ilišin, Bouillet, Gvozdanović, & Potočnik, 2013; Sekulić, 2014), could also have more effect on gender differences in all the levels of the ecological model. This is more obvious in more traditional countries, where the gender differences are greater (Rajhvajn Bulat, & Ajduković, 2012; Keresteš, 2002). The main purpose of this study was to examine these gender differences in predicting peer aggression in the traditional European country like Croatia.

Gender Differences in Potential Predictors of Peer Aggression

The most prominent gender differences in the potential predictor of peer aggression were found on an individual level and within the family microsystem, i.e., parental upbringing of children.

Deficiency in empathic concern and compassion was connected to antisocial and aggressive behavior in many studies (Espelage, Mebane, & Adams, 2004; Feshbach, 1997). Gender differences in empathy were found mostly for the affective aspect of empathy (i.e., empathic concern about other people's feelings), whereas boys showed a lower level of affective empathy (Kaukianien et al., 1999; Özkan & Gökçearslan, 2009). Also, there was stronger correlation to aggressive behavior and bullying for boys (Carlo, Raffaelli, Laible, & Meyer, 1999; Espelage & Swearer, 2004; Gini, Albiero, Benelli, & Altoè, 2007). In the study on secondary school students, gender moderated only the relation between cognitive empathy and physical violence, in a way that there was a significantly negative relation only among boys (Dinić et al., 2016).

Generally, the studies have shown that a hyperactive behavior, especially in children within dominate problems of impulsivity, is associated with aggression toward peers and bullying (Craig, 1998; Velki & Dudaš, 2016). Impulsive children have lower threshold on frustration, and consequently they act more aggressively in different situations (Olweus, 1998). Furthermore, ADHD is more commonly diagnosed in boys than girls, 4 vs. 1, (Velki, 2018a) and the dominant symptoms for boys are hyperactivity and impulsivity, which usually significantly interfere with peer interactions (Biederman et al., 2002; Cantwell, 1996; Ramtekkar, Reiersen, Todorov, & Todd, 2010; Rucklidge, 2010; Velki & Romstein, 2016).

Many studies have shown that parental upbringing have a direct influence on the children's aggressive behavior, for example a higher level of parental discord (You et al., 2014), low parental monitoring, and parental attitude supporting

fighting (Kim et al., 2011), more inductive parenting (Lee, 2010, 2011), harsh discipline and physical punishment (Schwartz, Dodge, Pettit, & Bates 1997; Shields & Cicchetti, 2001), lack of parental warmth and support (Olweus, 1998; Veenstra et al., 2005), were associated with aggressive behavior and bullying. What is more important is that these findings are under the influence of gender differences, which means that parents treat boys and girls differently (Zahn-Waxler, Shirtcliff, & Marceau, 2008), especially in a traditional society such as the post war society of Croatia (Groebel, 1999; Keresteš, 2002). Generally, the parenting style for boys promotes rough-and-tumble practices (Maccoby & Martin, 1983; Ruble & Martin, 1998), and use of more physical control and punishment (Endendijk et al., 2017; Kochanska, Barry, Stellern, & O'Bleness, 2009; Lytton & Romney, 1991), whereas the parenting practices for girls promote caring and close interpersonal relationships (Gilligan, 1982), while the parental control is characterized by support, empathy and interpersonal closeness (Wood & Eagly, 2012). Furthermore, meta-analytic studies in the Western countries have revealed that parents use more physical punishment for boys (Lytton & Romney, 1991), while mothers use more supportive speech with girls (Leaper, Anderson, & Sanders, 1998). Generally, it could be concluded for the traditional society that the parenting style for girls is more sensitive and supportive with more warmth and interpersonal closeness, while it is more harsh and disciplining with use of power for boys (Mandara, Murray, Telesford, Varner, & Richman, 2012; Tamis-LeMonda, Briggs, McClowry, & Snow, 2009).

Although a significant number of the above-mentioned studies have found gender differences in some personal and family characteristics, these differences have not yet been put in a direct connection to peer aggression. Furthermore, there were no studies starting from the ecological models, taking into account all the levels of the model, which tested gender differences in prediction of peer aggression.

Current Study

The study goal was to determine the gender differences in predicting peer aggression among primary school children in Croatia, Europe, by applying Bronfenbrenner's ecological model. The predictors for boys' and girls' peer aggression were tested separately. In addition, the outcome variable, aggression toward peers, was a multivariate measure that consisted of three measures of aggressive behavior towards peers**.** The previous researchers found gender difference in peer aggression, i.e., boys being more aggressive toward their peers than girls (Olweus, 2010). Furthermore there were found some gender differences in personal traits (a lower level of empathy and a higher level of impulsivity within boys; Carlo et al., 1999; Gini et al., 2007; Velki & Dudaš, 2016), and moreover in parental upbringing (more harsh discipline and more autonomy in traditional upbringing of boys, and more warmth and inductive reasoning for girls; Kochanska et al., 2009; Mandara

et al., 2012; Tamis-LeMonda et al., 2009; Velki & Bošnjak, 2012). Therefore, it was assumed that these gender differences would also have influences on the prediction of peer aggression. As variables from the distal level of ecological model did not have a direct influence on the child's behavior, but had an indirect influence through variables on the closer level of the ecological model (Bronfenbrenner, 1979), it was assumed that gender differences in prediction of peer aggression would be found only for interactions between variables from proximal (microsystem and mesosystem) and distal levels (exosystem), and not for variables from the distal level per se. Variables from the distal level could predict peer aggression in the same way for both genders.

Hypotheses

H1: Different predictors of peer aggression in boys and girls would be found on an individual level of Bronfenbrenner's' ecological model (i.e., personal traits such as the level of impulsivity and empathy, i.e., empathy and impulsivity are more strongly related to peer aggression among boys than among girls).

H2: Different predictors of peer aggression in boys and girls would be found on the microsystem level of Bronfenbrenner's' ecological model (i.e., family characteristics such as parental punishment, autonomy and warmth).

H3: Different predictors of peer aggression in boys and girls would be found on the mesosystem level of Bronfenbrenner's' ecological model (i.e., family characteristics in interaction within the school variables, such as parents' attendances at PTA, and the family income inequality among the students in the same class).

H4: At a distance level, exosystem, there would be no gender difference in prediction of peer aggression since these variables do not have a direct influence on students. Instead, they influence the closer level of ecological model through variables.

H5: Different interaction effects would be found for boys and girls as a consequence of different gender predictors on the closer level of ecological model (i.e., individual, micro, and meso-system level variables).

Method

Participants

Elementary school students from the eastern part of Croatia were chosen to participate in the research. Students from the fifth to the eighth grade from 58 classes from 6 schools participated in the research. The average number of students in a class was M = 22.72 (SD = 4.23), ranged from 14-33 students per class. A total number of participants was 880 students (52% of girls), as well as their parents (N = 880, 19% of fathers, 61% of mothers, and 20% of those who did not check

the gender). The average age of students was *M* = 12.8 (*SD* = 1.15), with the range from 10 to 15 years. Students' teachers (*N* = 107) also participated in the research (10.2% of male, 82.2% of female and 7.6% of those who did not check the gender).

Instruments

Demographic data. Students filled out a special form with demographic data, e.g., age, gender, a number of best friends, peer acceptance (2 items), and the school achievement (6 grades: the academic achievement from the previous grade and term, the final grade in Mathematics and Croatian at the end of the previous school year, and at the end of the previous term).

Peer Aggression among School Children Questionnaire (Velki, 2012). This instrument was designed for the self-assessment of peer aggression and victimization based on the behavioral approach, and it consisted of two scales (*k* = 38). The scale of peer aggression among children measured the frequency of aggression committed against peers at school, and the scale of peer victimization measured the frequency of experienced aggression at school. Only the scale of peer aggression was used for the purpose of this research. The scale of peer aggression among children (*k* = 19) consisted of items describing verbal aggression (the item example: *I spread gossip about someone*), physical aggression (the item example: *I hit or push someone*) and cyber aggression (the item example: *I insult others through social networks, like Facebook, Twitter, etc.*). Children indicated the frequency of every committed form of aggression on a 5-point Likert scale (from "*never*" to "*always/nearly every day*"). The result for the scale was computed as an arithmetic mean of responses to the corresponding items. The internal consistency for Peer Aggression Scale was Cronbach α = .83.

Peer Nomination and Self-nomination of Peer Aggression (Velki, 2012). The sociometric technique of peer nomination and self-nomination of peer aggression based on the definitional approach was applied in the research. The students were given definitions of three different types of peer aggression (verbal, physical, and cyber), and were asked to nominate the classmates from the name list of their class who behaved in the described way more often than the other students from the class. It was possible for a student to nominate himself/herself for the aggressive behavior. The definition of verbal peer aggression included behaviors such as teasing, gossiping, mocking, insulting, etc. The definition of physical peer aggression described a person who punched, pushed, hurt, threatened, etc. The definition of cyber peer aggression was also presented. The total score of peer nomination for every student was formed based on the proportion of nomination from all the students who filled peer nomination and theoretically ranged from 0 (without any nomination/self-nomination) to 3 (nomination/self-nomination for all three types of peer aggressive behavior).

Empathy questionnaire (Ivanović & Buško, 2008). Empathy questionnaire measured the degree of empathy in the primary school students (from the

fifth to the eighth grade), and it was divided into two parts (k = 22): affective and cognitive aspects of empathy. As cognitive aspects of the empathy scale had low internal consistency, only the affective aspect of the empathy scale was used for the purpose of the research. The affective aspect of empathy (k = 10) was defined as the experience of emotion as a reaction to the emotional state of another person, and only this subscale was used in the research (the item example: *I enjoy watching when someone opens a gift and looks happy*). Participants indicated their agreement with the described behavior on a 5-point Likert scale (from "*does not apply to me at all*" to "*it fully applies to me*"). The result for the subscale was computed as an arithmetic mean of responses to the corresponding items, and theoretically ranged from 0 to 4. The internal consistency for the subscale of affective empathy was satisfactory, Cronbach α = .79.

Parental Behavior Questionnaire (Keresteš et al., 2012). Parental Behavior Questionnaire examined the most common behavior of a mother and a father towards a child. There were three versions of the questionnaire, for the mother, for the father, and for the child. Only a version of the questionnaire for a child, which consisted of two identical questionnaires, one related to the mother's behavior, and the other to the father's behavior, was used in this research. Each of these two questionnaires consisted of 29 items. Participants indicated their agreement with the described mother's/father's behavior on a 4-point Likert scale (from "*not true at all*" to "*completely true*"). The result for each subscale was computed as an arithmetic mean of responses to the corresponding items, and theoretically ranged from 1 to 4. The questionnaire had a total of 7 subscales: Warmth (k = 4, e.g., *He/She shows me he loves me*), Autonomy (k = 4, e.g., *He/She admits me and respects as person*), Intrusiveness (k = 4, e.g., *He/She interrogates me about everything*), Supervision (k = 4, e.g., *He/She knows my friends well*), Permissiveness (k = 3, e.g., *He/She is being permissive to me*), Inductive Reasoning (k = 5, e.g., *He/She explains me why I need to abide by the rules*) and Punishment (k = 5, e.g., *He/She yells when I behave badly*). Combined scores of mother's and father's behavior was used for the purpose of the research. The internal consistency of subscales ranged from Cronbach α = .70 to α = .86. In preliminary analysis subscale Permissiveness did not have significant correlation with peer aggression r = .06 (p > .05), so it was left out from further analysis.

Impulsivity Scale (Vulić-Prtorić, 2006). Impulsivity scale was a part of the wider self-assessment HIP scale (Scale hyperactivity-impulsivity-attention, k = 19) designed to assess hyperactive, impulsive behaviors and attention problems. Only Impulsivity scale (k = 4, e.g., *Interrupt or disturb others in what they do or say*) was used for the purpose of the research, on which participants self-evaluated the frequency of the described behavior that occurred to him/her in the last 6 months on a 5-point Likert scale (from "*never*" to "*very often*"). The result for the subscale was computed as an arithmetic mean of responses to the corresponding items, with internal consistency Cronbach α = .72.

Scale of Perception of Neighborhood Dangerousness (Velki, 2012). Scale of Perception of Neighborhood Dangerousness consisted of 6 items that measured

different types of dangerousness to which children were potentially exposed in the neighborhood. It was a self-assessment scale on which participants indicated their agreement with the statements (e.g., *There's a drug in my neighborhood*) on a 5-point Likert scale (from "*strongly disagree*" to "*strongly agree*"). The total score was computed as an arithmetic mean of responses to all items. Internal consistency was Cronbach α = .81.

Exposure to the Media Scale (Velki, 2012). This self-report scale consisted of three items related to the amount of time children spent with media (watching TV daily, playing computer games, and browsing the Internet weekly). Students indicated the frequency of time spent with every media on a 5-point Likert scale (from "*never*" to "*more than 10 hours of watching television per day and more than 10 hours per week for the Internet and computer game*"). The total score was obtained as an arithmetic mean of answers to all the items. Internal consistency was Cronbach α = .66.

Croatian School Climate Survey for students (Velki, Kuterovac Jagodić & Antunović, 2014). Croatian School Climate Survey for students measured a global school climate, i.e., the sense of safety and belonging to the school, the relationship of teachers and students, and parental involvement at school. It was a self-assessment scale (k = 15) on which participants indicated their agreement with statements (e.g., *I enjoy learning in my school*) on a 5-point Likert scale (from "*strongly agree*" to "*strongly disagree*"). The total score was computed as an arithmetic mean of responses to all items. Internal consistency was Cronbach α = .92.

Attendance of Parents at the Parent-Teacher Meetings and Other School Events (Velki, 2012). To evaluate the frequency of parents' attendance to individual meetings, PTA meetings, and school events, homeroom teachers were asked to estimate the frequency of parents' arrivals. The homeroom teacher evaluated parents' arrival on a 3-point Likert scale by circling the corresponding number, whereas "1" meant that parents of that child never came, "2" that parents of that child sometimes came and "3" that parents of the child regularly came. The total score was computed as an arithmetic mean of two responses.

Socio-economic Status of the Family (SES: Velki, 2012). The parents provided data on socio-economic status of the family. Three different aspects related to socioeconomic status (employment, income and education level) were measured. A parent who filled out the questionnaire had given the information for himself/herself and for the other parent (the child's father/mother). The parents' answer for every aspect of SES was scored from 1 (lowest SES) to 4 (highest SES). The total score was computed as an arithmetic mean of all items (k = 6). Parents gave demographic data about gender and age, and also about the age of their partner.

Procedure

Ethical Commission of the Faculty of Social Sciences at University of Zagreb (Study of Psychology), and Ethical Commission of the Faculty of Education at Uni-

versity of Osijek approved the research. Cross-sectional data were collected during the summer school semester. During the teachers' meeting, it was explained how the research would be carried out. Also, all the teachers were asked to complete Croatian School Climate Survey for teachers and Policy against bullying at schools. For parents who did not come to PTA, the written material was send to their home. The homeroom teachers were asked to prepare a list of students from their class, so that the instruments (a sociometric procedure) could be prepared. At the next PTA meeting, the main researcher explained the purpose of the research and asked parents for a written consent for the child's participation. About 70% parents gave the informed consent for their and children's participation in the research. Parents also gave data about the family socio-economic status. Students' data were collected collectively during classes at schools. Before the data collection, students were clearly reminded of possibility to give up at any time, and they were guaranteed confidentiality of the data obtained in the research. Data collection lasted for about 45 minutes. During students' filling out the questionnaires, the homeroom teachers evaluated the frequency of parents' attendance to PTA and other school events.

Results

Most of the variables were obtained based on the arithmetic means of the above-described items of the questionnaires and scales. The average values of the sum of the students' academic achievement from the previous year and from the previous term were used for the variable School Achievement. The index of income inequality was obtained on the basis of the families' socioeconomic status. It provided a more precise measure of inequality within a particular group, in this case within the class which the child attended.

All the variables met the assumptions for conducting the multivariate multilevel modeling analysis (variances were not zero, there was no perfect multicollinearity, the predictors were not correlated with the external variables, assumptions about normal distribution of errors and linearity were also met).

Multivariate Multilevel Modeling

At the first level of the model, the latent construct or the multivariate outcome (a measurement model) was defined, which consisted of three measures of aggressive behavior towards peers (self-assessment of aggressive behavior, peer nomination, and self-nomination for aggressive behavior), previously set up to *z*-scores. In order to facilitate the interpretation, all predictor variables were centered on the overall mean (grand-mean centering method).

At the second level, variables that varied within a group (i.e., among the students) were defined. The following variables were tested as predictors: infrasystem: age, af-

fective empathy, impulsivity; microsystem-family: parental punishment, parental inductive reasoning, parental warmth, parental autonomy, parental supervision, parental intrusiveness; microsystem-peers: number of friends, peer acceptance; microsystem-school: school success; exosystem; time spent using media, and perception of neighborhood dangerousness. At the third level, variables that varied between classes were defined. Three variables were tested as predictors: the school climate (estimated by the students - microsystem-school), parents' attendance at the PTA meetings and other school events (mesosystem), and the index of income inequality (mesosystem). At the fourth level, variables that varied between schools (e.g., school policies against bullying, and the school climate assessed by the teachers) were defined, but the intraclass correlation coefficient (ICC) did not show a statistically significant variation between schools, so these variables were excluded from the further analysis. Therefore, the model that had 3 levels had been tested, and the above described analysis had been repeated twice separately for boys and girls. The analyses were done on the variance components (VC) of the covariance structure matrix by using the ML (maximum likelihood) estimation method. First, the basic models (Model A and Model A1) were tested with all the potential predictors. Then, there were tested variations of predictors from the second level of the model (between students), and from the third level (between classes), and models were built with significant variations. Afterwards, the potential interactions were tested, and final models (Model B and Model B1) were built based on significant interactions. Comparisons of the obtained model were tested by using the indicators of model fit.

Table 1 shows the basic descriptive statistics of all variables included in the research. Most of the variables were obtained based on the arithmetic means of the above-described items of questionnaires and scales. For the variable School Achievement, there were used the average values of the sum of the students' academic achievement from the previous year (a general achievement, the mathematics grade and the grade form Croatian) and from the previous term (a general achievement, the mathematics grade and the grade from Croatian). The achievement in mathematics and Croatian (with the general academic achievement at the end of the school year/term) was chosen because students in the primary school mostly had very good and excellent grades. This decreased the variability of the general academic achievement. Croatian and mathematics were usually considered to be the basic subjects in the primary school. Therefore, the criteria were more severe in comparison to some other subjects (Vrdoljak & Velki, 2012). Thus, it was expected that the variability would be higher in these variables in relation to the general academic achievement.

The index of income inequality was obtained on the basis of the families' socioeconomic status. It provided a more precise measure of inequality within a particular group, in this case within the class which the child attended. The value span ranged from 0 (representing the same income group) to 1 (representing a maximum inequality within the group). The index of income inequality was calculated based on Deatons' formula (1997):

$$G = \frac{N+1}{N-1} - \frac{2}{N(N-1)u}(\Sigma_{i=1}^{n} P_i X_i)$$

whereas *N* was a number of participants, u an average population income (the average SES for the specific class), *P* a rank of income of persons *i*, with income *X* (SES of that person). Accordingly, the richest person had a rank 1, and the poorest person had a rank *n*.

Table 1
Descriptive statistics for all variables included in the research

Variables	*N*	*Min*	*Max*	*M*	*SD*	*Sk*	*Ku*
Variables on the first level (multivariate outcome)							
self-assessment of aggressive behavior	879	1.00	3.42	1.30	0.30	2.50	3.73
self-nomination for aggressive behavior	720	0.00	3.00	0.46	0.72	1.67	2.51
peer nomination for aggressive behavior	720	0.00	3.00	0.24	0.56	2.46	3.82
Variables on the second level							
affective empathy	879	0.20	4.00	2.96	0.70	-1.00	1.15
impulsivity	869	1.00	5.00	2.40	0.79	0.63	0.63
number of friends	879	0.00	25.00	4.34	3.51	1.66	3.13
peer acceptance	879	1.00	3.00	2.64	0.48	-1.27	1.00
school achievement	876	1.17	5.00	3.75	0.89	-0.37	-0.74
parental inductive reasoning	877	1.00	4.00	3.12	0.64	-0.66	-0.15
parental punishment	874	1.00	4.00	2.11	0.63	0.37	-0.19
parental warmth	874	1.00	4.00	3.56	0.52	-1.62	2.52
parental autonomy	872	1.00	4.00	3.52	0.50	-1.38	2.02
parental intrusiveness	870	1.00	4.00	2.17	0.69	0.38	-0.39
parental supervision	874	1.00	4.00	3.17	0.64	-0.73	0.10
time spent using media	873	1.00	5.00	2.83	0.87	0.48	-0.57
neighborhood dangerousness	870	1.00	5.00	4.18	0.76	-1.27	1.71
Variables on the third level							
school climate	880	1.41	3.35	2.32	0.42	0.52	-0.11
index of income inequality	880	0.02	0.17	0.09	0.03	0.41	1.42
parent's attendance at school	880	1.68	3.00	2.26	0.29	-0.74	-0.79

Notes. N - number of participants*; Min* - minimum*; Max* - maximum*; M* - arithmetic mean*; SD* - standard deviation*; S* - skewness*; K* - kurtosis.

Results have shown (Table 2) that 23% (level 2; ICC=0.2300) of the total variability in boys' peer aggression can be explained by differences among stu-

dents, while only 6.55% (level 3, ICC=0.0655) of the total variability can be explained by differences among classes. For girls' peer aggression, 27.15% (level 2, ICC=0.2715) of the total variability can be explained by differences among students and 6.66% (level 3, ICC=0.0666) of the total variability can be explained by differences among classes.

Table 2
Estimates of null model of multilevel modeling for the criterion variable peer aggression for boys and girls

	Parameters	Boys	Girls
Fixed effects	Intercept	.119*	-.110*
Variance components			
Level 1	variability in aggression (individual differences)	.909**	.467**
Level 2	variability in aggression within classes	.297**	.191**
Level 3	variability in aggression between classes	.085*	.047*
Indicators of model fit			
	-2 Log Likelihood	3270.772	2660.173
	Akaike's Information Criterion (AIC)	3278.768	2668.173
	Hurvich and Tsai's Criterion (AICC)	3278.812	2668.214
	Bozdogan's Criterion (CAIC)	3302.740	2692.241
	Schwarz's Bayesian Criterion (BIC)	3298.739	2688.237

Note. * $p < .05$. ** $p < .01$.

The predictors of boys' peer aggression explained 50.43% of the variance on the level 2 (between students), but nonetheless significant 14.09% still remained unexplained. On the third level, 60.54% of the variance (between classes) was explained, and another 3.19% of unexplained but insignificant variance (Table 3, variance components in Model A) remained.

For girls' peer aggression on the level 2 (between students), predictors explained 48.93% of the variance, but still remained significant 17.73% of unexplained variance. On the third level, predictors explained 58.21% of the variance (between classes), and another 3.56% of unexplained but insignificant variance remained (Table 3, variance components in Model A1).

Table 3
Predictors' models of multilevel modeling for peer aggression for boys and girls

		Boys		Girls	
		Model A	Model B	Model A1	Model B1
Fixed effects estimates	Intercept	.026	.019	-.047	-.041
Level 2	age	.051	.048	-.027	-.026
	affective empathy	-.148**	-.148**	.005	-.007
	impulsivity	.292**	.271**	.331**	.325**
	number of friends	-.010	-.023	-.014	-.024
	peer acceptance	-.086	-.079	-.022	-.035
	school achievement	-.050	-.041	-.042	-.039
	parental inductive reasoning	.165*	.155*	.044	.016
	parental punishment	.222**	.212**	.050	.055
	parental warmth	.151	.153	-.142*	-.146*
	parental autonomy	-.211*	-.221*	.076	.108
	parental intrusiveness	-.065	-.057	.007	.013
	parental supervision	-.071	-.081	-.051	-.068
	time spent using media	.116**	.103*	.067*	.065*
	neighborhood dangerousness	.153**	.123**	.163**	.158**
Interactions on the second level	parental punishment x neighborhood dangerousness	-	.138*	-	-
Level 3	school climate	.231*	.216*	-.032	-.027
	parents attendance at the school	.004	.014	.263*	.277*
	index of income inequality	6.755**	6.577**	.796	.797
Interactions between second and third level predictors	neighborhood dangerousness x school climate	-	.309**	-	-
	neighborhood dangerousness x income inequality	-	4.234*	-	-
	impulsivity x parents attendance at the school	-	-	-	.389**
Variance components					
Level 1	variability in aggression (individual differences)	.865**	.866**	.434**	.433**
Level 2	variability in aggression within classes	.147**	.125**	.098**	.093**

Level 3	variability in aggression between classes	.033*	.029	.020	.019
Indicators of model fit					
	-2 Log Likelihood	2979.74	2961.31	2434.30	2423.67
	Akaike's Information Criterion (AIC)	3021.742	3009.314	2476.301	2467.671
	Hurvich and Tsai's Criterion (AICC)	3022.653	3010.491	2477.15	2468.602
	Bozdogan's Criterion (CAIC)	3146.731	3152.154	2602.486	2599.869
	Schwarz's Bayesian Criterion (BIC)	3125.731	3128.147	2581.488	2577.873
Degrees of freedom	Number of parameters	21	24	21	22

Note. * $p < .05$. ** $p < .01$.

There were significant interactions of predictors on the second level of the model, and also there were significant variations of the second level predictor variables between classes (Table 4), so the final model was the Model B and B1.

Table 4
Variations of predictors from the second level of the model (between students), on third level (between classes) for peer aggression for boys and girls

Variance components		Boys	Girls
Level 1	variability in aggression	.863**	.433**
$Intercept_2$	within classes	.048	.030
	affective empathy	.061	-
	impulsivity	.005	.031*
	parental inductive reasoning	.044	-
	parental punishment	.000	-
	parental autonomy	.000	-
	parental warmth	-	.055*
	time spent using media	.012	.032*
	neighborhood dangerousness	.068*	.029
$Intercept_3$	between classes	.024	.018

Note. * $p < .05$. ** $p < .01$.

Model fit for multilevel models of boys' and girls' peer aggression (Table 3) was tested by using the χ^2 likelihood ratio test. Comparison of Model A with Model

B, $\chi^2 = 18.434$, $p < .01$, showed statistically significant improvement of model fit for Model B. Also, other indicators of model fit (AIC and AICC; Table 3) showed better model fit of Model B compared to models A. Therefore, it was decided to take into account the Model B as a final solution for the prediction of boys' peer aggression. The same results were obtained or girls' peer aggression. Comparison of Model A1 with Model B1, $\chi^2 = 10.628$, $p < .01$, showed a statistically significant improvement of model fit for Model B, while the other indicators of model fit (AIC, AICC, CAIC and BIC; Table 3) showed better model fit of Model B1.

Model B obtained the following significant predictors of boys' peer aggression that explained the variability between students: more impulsive behavior, less empathy, more parental punishment, more parental inductive reasoning, less parental autonomy, more time spent with media, and a greater perception of neighborhood dangerousness. There were two significant predictors on the third level, more negative school climate and index of income inequality (higher inequality), which explained the variability between classes. Furthermore, the model B had three significant interaction effects, i.e., between parental punishment and the perception of neighborhood dangerousness (Figure 1), between perception of neighborhood dangerousness and the school climate (Figure 2), and between perception of neighborhood dangerousness and income inequality (Figure 3).

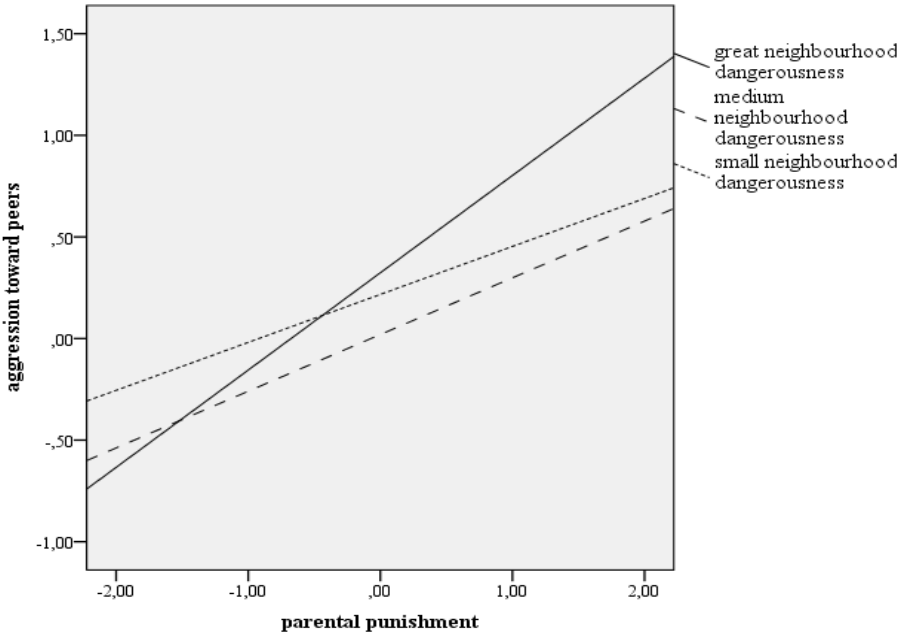

Figure 1. Interaction effects between parental punishment and perception of neighborhood dangerousness for aggression toward peers on the second level of the model (within the class) for boys.

Figure 1 shows the interaction effect of parental punishment and perception of neighborhood dangerousness on the second level of the model. In cases where the student perceived great neighborhood dangerousness, the parental punishment was more associated with boys' aggression towards their peers, but in situations where students perceived medium or low neighborhood dangerousness, this correlation was weaker.

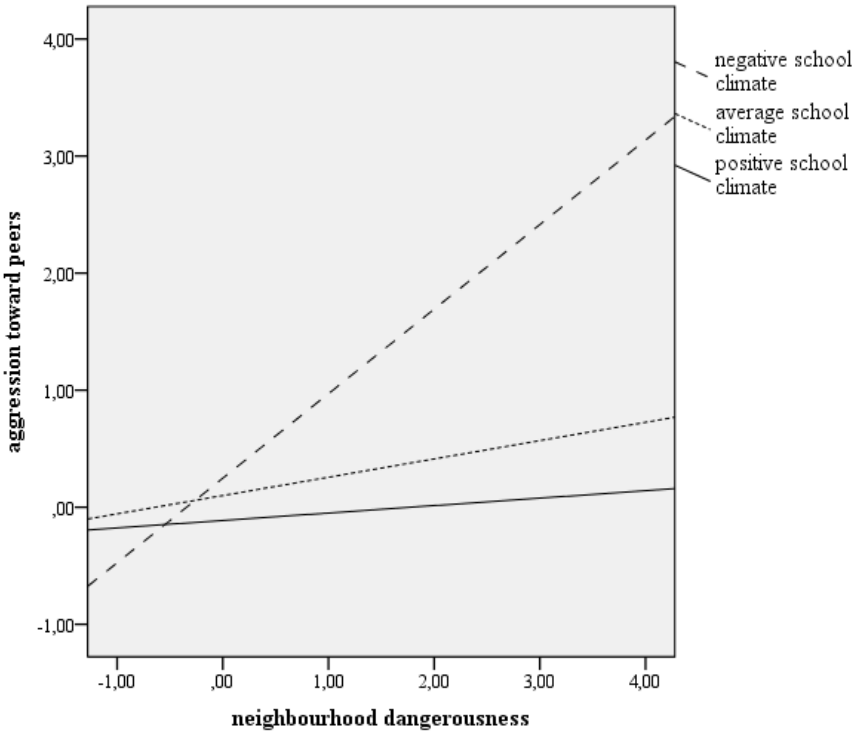

Figure 2. Interaction effects between perception of neighborhood dangerousness and the school climate for aggression toward peers on the third level of the model (between the class) for boys.

Figure 2 shows the interaction effect of perception of neighborhood dangerousness and the school climate on the third level of the model. In classes where students perceived negative school climate, the perception of neighborhood dangerousness was more strongly associated with boys' aggression towards peers. On the contrary, in classes where students perceived a positive school climate, there was almost no association between perception of neighborhood dangerousness and boys' aggression.

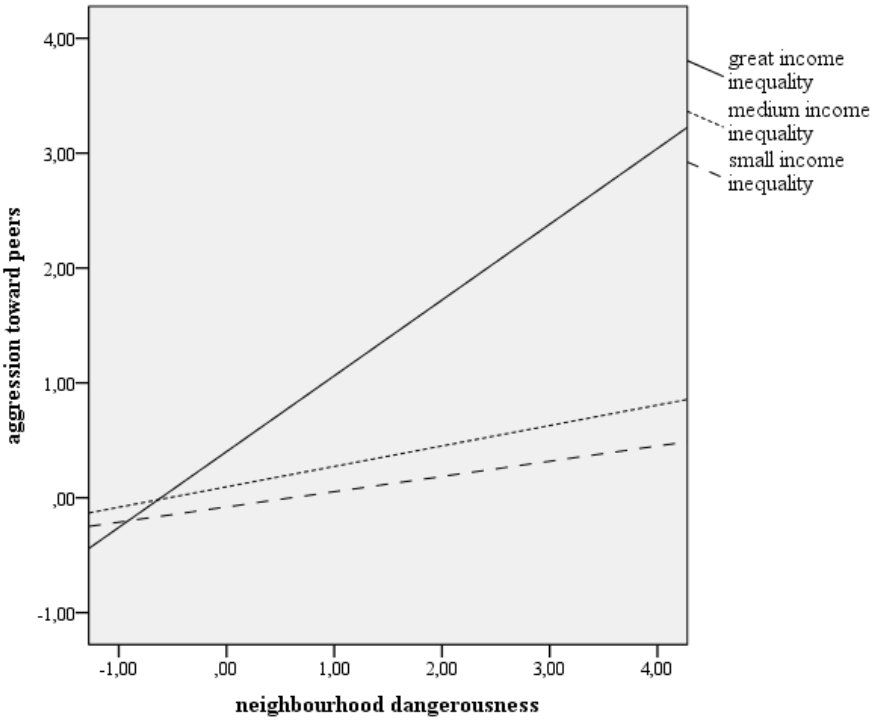

Figure 3. Interaction effects between perception of neighborhood dangerousness and income inequality for aggression toward peers on the the third level of the model (between the class) for boys.

Figure 3 shows the interaction effect of perception of neighborhood dangerousness and income inequality on the third level of the model. In classes where students perceived great income inequality between their families, perception of neighborhood dangerousness was more strongly associated with boys' aggression towards peers. However, in classes where students perceived low- or no-income inequality, there was almost no association between perception of neighborhood dangerousness and boys' aggression.

Model B1 obtained the following significant predictors of girls' peer aggression that explained the variability between students: more impulsive behavior, less parental warmth, more time spent with media, and a greater perception of neighborhood dangerousness. There was only one significant predictor at the third level, parents' attendance at school, which explained the variability between classes. Furthermore, the model B1 had one significant interaction effects, i.e., between impulsivity and parents' attendances at school (Figure 4).

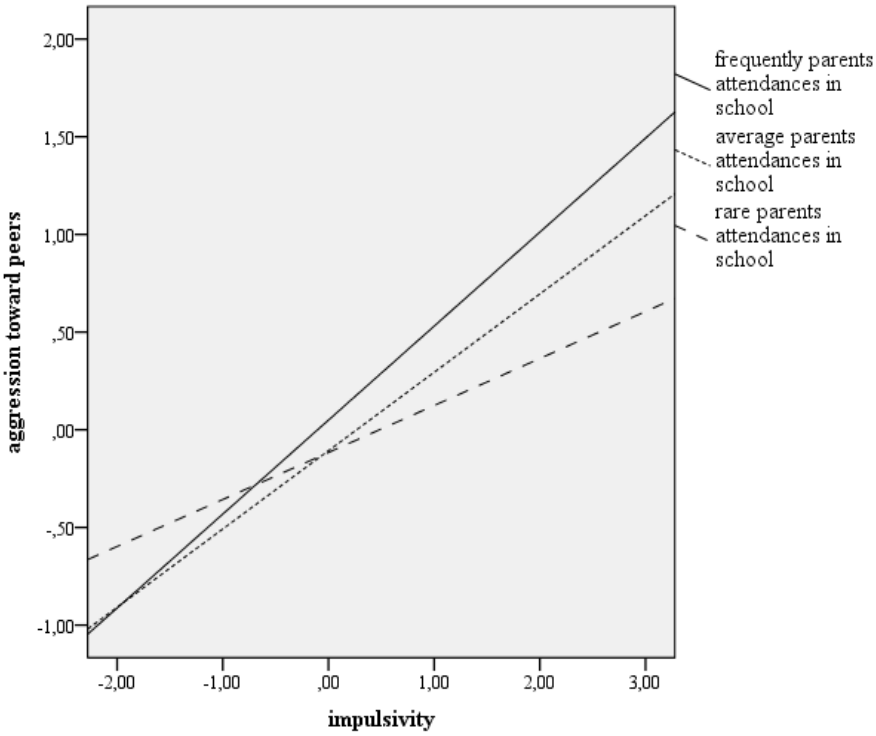

Figure 4. Interaction effects between impulsivity and parents' attendances at school for aggression toward peers on the third level of the model (between the class) for girls.

Figure 4 shows the interaction effect of impulsivity and parents' attendances at school on the third level of the model. In classes where parents often came to PTA, impulsivity was more strongly associated with girls' aggression towards peers, but in classes where parents rarely came to PTA, the association between impulsivity and girls' aggression was somehow weaker, but still significant.

Discussion

In accordance with the study goal, predictors for boys' and girls' aggression toward peers were checked separately and interpreted within the ecological perspective.

From an individual level of Bronfenbrenner's' ecological model, different predictors for boys' and girls' prediction of peer aggression were confirmed. Lower level of affective empathy was a significant predictor only for boys' aggressive behavior, but not for girls. Girls generally showed more empathic behavior (Espelage

& Swearer, 2004) and a genuine concern about other peoples' emotions than boys did. In contrast, boys with lower levels of affective empathy did not sympathize with other children, and showed no concern for their feelings without realizing that their aggressive behavior could hurt other children. Furthermore, higher degree of impulsivity in both boys and girls was a significant predictor of aggression toward peers. Interestingly, impulsiveness was a stronger predictor for girls than for boys. Such results could be explained by normative beliefs whereas boys' impulsive behavior was being more tolerated, especially in a traditional society like Croatia (Sekulić, 2014; Velki, 2018b). Moreover, the researches have shown that boys are more impulsive than girls (Craig, 1998). A smaller amount of impulsive behavior is considered a normal developmental feature of boys, and only high or extreme impulsiveness can be noted in connection to aggression. For girls, different normative beliefs prevail, girls are quieter and more peaceful than boys are, and a slight deviation from the average impulsive behavior in girls can be a good predictor of aggressive behavior.

From the microsystem level of Bronfenbrenner's' ecological model, different family predictors underline aggression in boys and girls. More punishment, more inductive reasoning and less autonomy are good predictors of aggressive behavior for boys. Harsh discipline, especially in families subject to corporal punishment, often borders with abusive parenting has proven to be a good predictor of aggression toward peers (Ahmed & Braithwaite, 2004). Previous studies have also shown that the punishment is more often used for boys living in traditional families (Endendijk et al., 2017; Kochanska et al., 2009). In addition to punishing, corrective educational practices also include alternative punishment, with the intention to regulate unwanted child behavior, but without the use of an aversive stimulus, e.g., explanation and teaching, ignoring inappropriate behavior, etc. (Delale & Pećnik, 2009). Therefore, inductive reasoning is probably the parent's reaction to boys' aggression. Lack of child's autonomy within the family, where the parents are over-involved in the child's educational and extracurricular activities, can lead to aggressive behavior toward peers (Barber, 2002). For traditional upbringing of boys, it is usual for parents to be over-controlling (Lytton & Romney, 1991). In relationships with peers, the boys are trying to compensate for the lack of autonomy in the family, and overly want to gain independence, usually by using aggression. For girls, only a lack of parental warmth is a significant predictor of peer aggression. Upbringing of girls in more traditional society includes more sensitive and supportive parental style with more warmth (Kochanska et al., 2009; Tamis-LeMonda et al., 2009), and a lack of warmth can cause problems in other significant relationships, such the ones with peers.

Apart from gender differences in the family upbringing, another predictor on the microsystem level is significant for boys' aggressive behavior but not for girls'. It is a negative school climate. At schools where the negative school climate prevails, students have no sense of belonging to school, they do not feel safe and welcome to school (Newman, Murray, & Lussier, 2001). As boys are likely to have more problems in the relationship with the teachers, consequently they will also have more negative perception of the school climate and show more aggressive behavior.

From the mesosystem level of Bronfenbrenner's' ecological model, different predictors are significant for boys' and girls' aggression toward peers. Greater family income inequality within class that boys attend is a significant predictor of boys' aggression, which is in accordance with the previous studies (Elgar, Craig, Boyce, Morgan, & Vella-Zarb 2009; Wilkinson & Pickett, 2006). Exposure to stressful life events, such as low socioeconomic conditions (poverty, loss of work, etc. which is typical for Croatian society), increase the psychological stress of parents and indirectly leads to failure and difficulties in parenting. It is more common in a traditional society that these family problems lead to harsh discipline that is more frequent in upbringing of boys. A significant predictor of aggression for girls is parents' attendance at school. In classes where parents more often come to school, there is more aggression in girls' behavior. It is possible that in classes where there is more aggression and more general problems, parents often come to school either independently or at the invitation of teachers. Furthermore, as aggressive behavior is more common in boys, when it is more pronounced. In girls it is more deviant from norms in some way, and therefore parents are more involved in solving such problems.

At distance level of Bronfenbrenner's ecological model, exosystem, there are no gender differences in prediction of peer aggression. Both predictors, time spent using media and perception of neighborhood dangerousness were significant for boys' and girls' aggression. Although, time spent using media proved to be a slightly stronger predictor for boys. Boys often spent time playing violent computer games (Barboza et al., 2009; Genitle & Walsh, 2002) and were more likely to watch violent contents on television (Kuntsche, 2004, Pšunder & Cvek, 2012). In most violent computer games and violent movies, the main heroes were men who actually served as a model that boys imitated in the school situations. The perception of neighborhood dangerousness proved to be a slightly stronger predictor for girls. Probably due to more sensitive and warmer upbringing of girls (Mandara et al., 2012; Tamis-LeMonda et al., 2009) where aggression was not a normative behavior for them, and perhaps even a small amount of violence was sufficient for girls to adopt and pass it on in the school situations.

Finally, different interaction effects for boys and girls were confirmed. Neighborhood dangerousness had moderation effect in connection between parental punishment and aggressive behaviors in boys. If boys lived in dangerousness neighborhood, the parental punishment was more strongly associated with boys' aggressive behavior. Boys who expressed aggressive behavior could have learned such behavior within the family where punishment was present (which was more for boys living in a traditional society). Furthermore, it was possible that parents in dangerousness neighborhood were more concerned about the safety of their child and were prone to strict discipline and punishment to protect it. Moreover, it was more likely that families on the margins of poverty lived in dangerous neighborhoods, in which common practice was strict punishment that often led to a child abuse (Buljan Flander & Kocijan Hercigonja, 2003; Cicchetti & Cohen, 2006).

Another significant interaction has shown moderation effect of the school climate in connection between the neighborhood dangerousness and peer aggression in boys. In the classrooms where the negative school climate prevails, the perception of neighborhood dangerousness is more strongly associated with boys' aggression toward peers. The moderating effect of the school climate has proved to be significant in other studies (Espelage & Swearer, 2009). This finding is very important because it points to the fact that the negative impact of the community (neighborhood dangerousness) can be neutralized if the child attends the school where he feels accepted and safe.

The final significant interaction has shown moderation effects of income inequality in connection between neighborhood dangerousness and peer aggression in boys. In classrooms where large differences in the family income prevail, neighborhood dangerousness is more strongly associated with peer aggression in boys. Children easily see the material differences (e.g., clothes, mobile phones, etc.) within these classes, which can cause frustration because they cannot change their position. A boy living in a dangerous neighborhood has stored many aggressive scenarios in his memory, and when he comes to a state of frustration caused by huge and obvious material differences, he is likely to recall an aggressive scenario stored in his memory (seen or experienced in a dangerous neighborhood) and will behave accordingly (Huesmann, 1994).

Only one significant interaction has been found for girls, a moderating effect of parents' attendance at school in connection between impulsiveness and aggression in girls. In classes where parents often come to school, impulsiveness is more strongly associated with peer aggression in girls. Parents are more likely to come to school when there are more problematic behaviors, as well as impulsiveness in girls, which is closely related to aggression (Velki, 2018b). Parents will be more likely to come to school (either self-initially as parents who want to solve the problem or at the invitation of teachers) especially if the impulsive behavior occurs in girls, which is considered less normative and more deviating than in boys.

Generally, the current research has shown that the chosen predictors better explain aggressive behavior for boys than for girls. Less predictors have been significant for girls and generally, they are weaker than boys' predictors are. It can be concluded that there is a variety of factors underlying in boys vs girls aggressive behavior, and that predictors from the proximal level of Bronfenbrenner's' ecological model are more gender sensitive than the ones from the distal level.

Prevention and Policy Implications

Peer aggression mostly happens at school, during the break, lunch, on toilets and hallways, and even in the classrooms (Velki & Vrdoljak, 2013), so the prevention program is a good starting point in an educational institution, i.e., at school. As a place where children spent half, or even more, time of the day, educational experts should be the first ones introducing prevention programs at schools and in classrooms, also

including parents and the whole community in such programs. As the results of the obtained research show, different predictors influence boys' and girls' aggressive behavior. This must be taken into consideration when implementing the preventive programs. Different strategies and activities should be introduced to aggressive children, depending on their gender. Distal influence is equally important for all children, i.e., influence of media violence and neighborhood dangerousness. However, it is more important for boys to work on activities that facilitate empathy, like role-playing game or taking someone other's perspective, working on the strategies that will help them to cope with their negative emotions. Also, it is more important for boys to develop tolerance, because differences in income of their peers have appeared to be significant in prediction of their aggression. Furthermore, the school climate has been shown very important for boys' aggressive behavior, and that is something which the school can directly work on. A positive school climate, where all students feel accepted, safe and welcome, is something that is beneficial for all, including teachers, students and even parents. The obtained results have also shown different influences of parental upbringing on boys' and girls' aggressive behaviors. Harsh punishment and a lack of autonomy in boys, and a lack of parental warmth in girls, facilitate aggression in children. Knowing these differences in upbringing, the school can act as an educational institution for parents as well. Educational experts can organize lectures for parents or offer them a school counselling. Raising parents' awareness on how important is proper upbringing of children is essential for a good prevention, because it is almost impossible to achieve a long-term progress without parents help and involvement.

Contributions and Limitations of the Research

Several important contributions could be drowned from the obtained research. This is one of the first studies in Croatia, and in Europe, that has applied an integrative ecological approach to the issue of gender differences in predicting peer aggression. Previous studies have been mostly done in the USA, which has different cultural background. This is important for several reasons; firstly, the proximal and distal effects have been tested simultaneously within the specific traditional community, and secondly, gender differences for prediction of peer aggression have been tested on the same generation of students and in the same way for boys and girls, which gives us a good starting point for generalization of data for a traditional culture. Moreover, the line with practical implication can also be driven, i.e., within prevention programs that are not usually specific to gender. Furthermore, some important methodological contributions can be noted: the application of different approaches (definitional and behavioral), and methods of measurement of peer aggression (self-assessment, peer nomination, self-nomination), and collection of data on individual and contextual characteristics have been taken from several sources (i.e., students, parents and teachers), which provide a more realistic point of view.

However, it is significant to mention the shortcomings of the research. The selection of schools which participated in the survey was random, but all schools

were from one county, and only elementary school students participated in the research (from the fifth to the eighth grade), which limited the result generalization to other students' population. Although this county was the most affected by the patriotic war, and it was a good example of a traditional society, the results showed a slightly higher prevalence of peer aggression in relation to the data from the national sample (Rajhvan-Bulut & Ajduković, 2012). Some other possible limitations were the following: small proportion of students' fathers (19%) who participated in research, the research was not anonymous, which could produce socially desirable answers. Moreover, some other possible independent variables (e.g., parent's gender, self-concept, previous history of victimization, subculture, etc.), which could have influence on a child aggressive behavior, were not included in the research. Finally, the research was cross-sectional in its design.

Conclusion

The obtained research has confirmed the results from some previous studies conducted in Croatia and worldwide. Most studies of peer aggression and bullying have shown that the gender is a significant predictor (Kim et al., 2011; Lee, 2010; Wei et al., 2010; You et al., 2014), and furthermore that individual characteristics and parental styles differ depending on the child's gender (Gini et al., 2007; Mandara et al., 2012; Velki, 2018b). However, the obtained research has additionally shown that it is necessary to consider gender of perpetrators when predicting the peer aggression. Different mechanisms are found in background of boys' vs girls' aggressive behavior, which points out that it is essential to use different approaches, which are gender depending, in dealing with peer aggression at schools. In addition, it is necessary to examine gender differences in predictions of different types of peer aggression, such as physical, verbal or relational. In order to examine the influence of the society, i.e., traditional vs modern, future studies should examine the characteristics of different regions and sub-cultures, and especially the cross-cultural studies are desirable. Moreover, applying a longitudinal design is preferable.

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MOŽEMO LI ISTIM ČIMBENICIMA PREDVIĐATI VRŠNJAČKO NASILJE KOD DJEČAKA I DJEVOJČICA?

Primjenjujući ekološki pristup na problematiku vršnjačkog nasilja, cilj ovog istraživanja bio je utvrditi možemo li istim prediktorima predviđati vršnjačko nasilno ponašanje kod dječaka i kod djevojčica. U istraživanju je sudjelovalo 880 učenika (48% dječaka i 52% djevojčica) od petog do osmog razreda osnovne škole i isto toliko njihovih roditelja, kao i 107 nastavnika. Djeca su dala neke osnovne demografske podatke (dob, spol, školski uspjeh, broj prijatelja), nominirali su nasilne vršnjake te procijenili vlastito nasilno ponašanje, stupanj afektivne empatije i impulzivnosti, školsku klimu, roditeljsko ponašanje, opasnost susjedstva i utjecaj medija. Roditelji su dali podatke koji se odnose na socioekonomski status obitelji, a nastavnici koji se odnose na dolaske roditelja u školu. Multivarijantim višerazinskog modeliranjem utvrđeno je kako različiti prediktori predviđaju vršnjačko nasilje kod dječaka u odnosu na djevojčice. Općenito se pokazalo kako su odabrani prediktori bolje objasnili nasilno ponašanje za dječake nego za djevojčice. Glavne razlike bile su bile su u domenu individualnih karakteristika i obiteljskom mikrosustavu, odnosno više je statistički značajnijih prediktora dobiveno za dječake, a također su i neki distalni prediktori u interakciji s individualnim karakteristikama i obiteljskim mikrosustavom bili važni u objašnjenju nasilnog ponašanja u dječaka. Rezultati istraživanja pokazuju da je rod snažno utjecao na vršnjačku agresiju. Psihološke karakteristike, kao i roditeljski odgoj, bolje su objasnili vršnjačko nasilje u dječaka. Dobiveni nalazi su također vrlo važni za školsku politiku, tj. programi intervencije i prevencije vršnjačkog nasilja trebali bi se razlikovati ovisno o rodu djeteta.

Ključne riječi: ekološki model, prediktori, rod, vršnjačka agresija

PRILOG 2. *

VELKI, T. (2018). VERIFYING THE ECOLOGICAL MODEL OF PEER AGGRESSION ON CROATIAN STUDENTS. *PSYCHOLOGY IN THE SCHOOLS, 55*(10), 1302–1320. DOI: 10.1002/PITS.2217

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RESEARCH ARTICLE

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Verifying the ecological model of peer aggression on Croatian students

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Abstract

Using the ecological approach, the goal of this study was to determine the predictors of physical and verbal peer aggressive behavior. The participants were 880 school students from the fifth to eighth grade (48% boys and 52% girls) and the same number of parents (19% fathers and 61% mothers) as well as 107 teachers. The main analysis was performed using multivariate–multilevel modeling. The following significant predictors of physical peer aggression were obtained: Boys, a greater degree of impulsivity, more parental punishment, poorer school success, more time spent with the media, and the perception of great neighborhood dangerousness. For verbal peer aggression, the significant predictors were: A greater degree of impulsivity, lower level of affective empathy, more parental punishment, lack of parental supervision, lesser peer acceptance, large differences in family income, more time spent with the media, and the perception of great neighborhood dangerousness. A moderating effect of neighborhood dangerousness and parental supervision was found. The results were interpreted within Bronfenbrenner's ecological model.

KEYWORDS
ecological model, elementary school children, peer aggression, predictors

1 | INTRODUCTION

In recent literature, there is much debate about the distinction between the terms bullying and peer aggression, which are in many studies used as synonyms (Cornell, Bandyopadhyay, & Espelage, 2010). Peer aggression is defined as all behaviors intended to physically or psychologically hurt or harm another person (Berkowitz, 1993; Hawley & Vaughn, 2003). Bullying is considered as a more severe form of aggression (Olweus, 1993). A commonly

used and widely accepted definition of bullying is Olweus' adapted definition (Whitney & Smith, 1993), "We say a child is being bullied or picked on, when another child or a group of children say nasty and unpleasant things to him or her. It is also bullying when a child is hit, kicked, threatened, locked inside a room, sent nasty notes, when no one ever talks to them, and things like that. These things can happen frequently, and it is difficult for the child being bullied to defend him or herself. It is also bullying when a child is teased repeatedly in a nasty way. But it is *not bullying* when two children of about the same strength have the odd fight or a quarrel." (p. 7). By comparing these two definitions, it can be concluded that bullying and peer aggression may look behaviorally the same but bullying has some additional distinctive characteristics, that is, it is intentional, repetitive, and behavior with an imbalance in power and/or strength between the victim and the bully (Olweus, 1993).

2 | A REVIEW OF STUDIES ON THE APPLICATIONS OF ECOLOGICAL MODELS TO THE PROBLEM OF BULLYING AND PEER AGGRESSION

Even though many studies have dealt with the issue of bullying and peer aggression, only a limited number of these took into account the complexity of this phenomenon and in accordance with this researched bullying and peer aggression as part of more complex models of human behavior, such as Bronfenbrenner's ecological model (Swearer & Doll, 2001; Swearer & Espelage, 2004).

One of the first studies that applied Bronfenbrenner's ecological model was the study conducted by Khoury-Kassabri, Benbenishty, Avi Astor and Zeira (2004). The authors tested the predictors of student victimization in elementary and middle school students, but did not test the predictors of bullying or peer aggression. The socioecological model of bullying in the United States was tested by Swearer et al. (2006) who showed that negative school climate and socializing with peers who had positive attitudes toward bullying were good predictors of bullying. This was one of the first published studies that applied the ecological model in testing the predictors of bullying. Espelage and Swearer (2009) tested the moderator effect of school climate in the ecological model of bullying on middle school students. They tested both groups of predictors for bullying and victimization and reported that the use of alcohol and drugs, depression and suicidal thoughts, negative peer pressure, and lack of parental care were significant predictors of bullying. School climate had significant positive moderator effects. As a result of the positive influence of school climate, the correlation between the lack of parental care, and negative peer pressure with bullying was decreasing. The same authors (Espelage & Swearer, 2009) tested the ecological model of bullying on a representative sample of middle school students and showed that previous victimization, negative family environment, a higher level of delinquency in school, and the use of drugs and alcohol were significant predictors of bullying.

Barboza et al. (2009) used the definitional approach and tested the predictors of bullying from all levels of the ecological model on an US national sample of elementary school students. Significant predictors of bullying were the following: Helplessness, previous victimization, increase in parents' income, race (white/Caucasian children), communication problems with parents, greater acceptance by peers and more friends, indifference of teachers, low expectations of academic achievement by parents and teachers, permissiveness of parents and teachers, negative school climate, and more hours spent watching television. Bowes et al. (2009) conducted the first longitudinal study that tested the ecological model of bullying in the United States on a national sample of twins. Significant predictors were the following: externalized child behavior, low family socioeconomic status (SES), parental antisocial behavior, domestic violence, maternal indifference, child abuse, and a large number of children in school. Bullying behavior was operationalized through interviews with mothers without a clear definition. Carvalhosa (2009) tested the ecological model of bullying on elementary and high school students by using the definitional approach, but the data was more than 10 years old. Bullying was predicted by externalizing behaviors, lower support from teachers and the lower or higher gross domestic product (GDP) countries (U-shaped curve). Kim, Orpinas, Kamphaus, and Kelder (2011) tested the influences of four risk domains (individual, family, community, and media) on the

development of peer aggression. Significant predictors of peer aggression were: being male, lower academic achievement, other family living situation (i.e., not living with both parents), low parental monitoring, parental attitude supporting fighting, higher rates of community violence, and more hours spent watching TV.

Lee (2011) conducted research on middle school students in the United States, testing the predictors for bullying from all levels of the ecological model. Among individual characteristics, significant predictors were positive attitude toward aggression and seeking fun. These predictors also affected interaction with peers, which in turn affected the school climate, where a negative school climate increased the incidence of bullying. From the family environment, significant predictors were negative family experience (which leads to the formation of positive attitudes toward aggression and increases seeking fun) and positive parenting (which leads to high self-respect, i.e., a risk factor for bullying). At the mesosystem level, parental communication with teachers and peers significantly affected the individual characteristics of the child and the school climate. The macrosystem had direct and indirect effects on bullying. In cultures in which children perceive the community and peer groups as more collectivistic, they more often perceive the school climate as positive and less often have positive attitudes toward aggression. Collectivist-oriented groups promote a positive school climate, reduce individual aggressive tendencies and prevent the occurrence of bullying.

Outside the United States, in Asia, Lee (2010) first tested the ecological model of bullying on Korean middle school students. Significant predictors were male students, seeking fun, dominance, positive attitudes towards aggression, intolerance of diversity, previous victimization, authoritarian parenting style, weak moral authority of teachers, teachers' lack of concern about the problem of bullying, and pseudofriendship (socializing with dominant or deviant peers). Wei, Williams, Chen, and Chang (2010) conducted similar research on Taiwanese students. For verbal and physical bullying, significant predictors were the following: Being male, depression, delinquent behavior, and lack of support and abuse by teachers. At the exosystem level (school size and the ratio of the number of teacher–students), there were no significant predictors. Yuhong (2012) tested the ecological model on a representative population of high school Chinese students but only for victimization, not for bullying. Another important study was done in Korea. You, Kim, and Kim (2014) examined the long-term effects of individual, family and school factors on bullying and victimization of middle school students. Significant predictors of verbal and physical bullying were being male, a lack of self-control, lack of social skills, higher number of deviant friends, and higher level of parental discord. Additionally, physical bullying was predicted by high level of aggression, lower teacher support, and lack of parental supervision.

In Europe, there was only one study that applied the ecological perspective concerning this problem. In Spain, Ferrer, Ruiz, Amador and Orford (2011) analysed the relationships between community, family, school, and individual characteristic, but tested only the predictors of victimization, not bullying.

3 | CONCLUSION ON THE CONDUCTED STUDIES

From this review of the applied ecological framework in the studies of bullying, a significant shift can be noted in the application of the theoretical framework and in the use of an improved methodology and advanced statistical analysis. The measurements of bullying and peer aggression are no longer just self-assessed, but the evaluation is also done by other significant persons (e.g., parents, peers, and teachers). Furthermore, numerous instruments for measuring various correlates of bullying and aggressive behavior have been developed. An important step forward in the use of the statistical analysis, which initially was only univariate analysis (e.g., most commonly used regression analysis and ANOVA), and grew into more complex multivariate analysis (e.g., hierarchical linear modeling and structural equation modeling).

However, only a small number of studies took into account all of these advantages (Table 1). Samples are often not representative (e.g., research on twins; Bowes et al., 2009) which makes it difficult to generalize the obtained results. Furthermore, the studies used different measurement methods of bullying (e.g., self-assessment and

TABLE 1 Review of studies that applied Bronfenbrenners' ecological model of peer aggression or bullying

Country	Study authors	Sample[a]	Different types of peer violence of bullying	Clear operationalized definition of bullying	Measurement method
Israel	Khoury-Kassabri, Benbenishty, Avi Astor and Zeira (2004)	Nationally representative sample of elementary and middle school students	Physical and verbal-social	No—measured victimization	Behavioral approach
USA	Swearer et al. (2006)	Elementary school students	No	Yes	Behavioral approach
	Espelage and Swearer (2009a)	Middle school students	No	No—only the criteria for peer aggression were met	Behavioral approach
	Espelage and Swearer (2009b)	Representative sample of middle school students	No	No—only the criteria for peer aggression were met	Behavioral approach
	Barboza et al. (2009)	National sample of elementary school students	No	Yes	Definitional approach
	Bowes et al. (2009)	National sample of twins	No	No—interviews with mothers	Behavioral approach
	Carvalhosa (2009)	Elementary and high school students	No	Yes	Definitional approach
	Kim et al. (2011)	Middle school	No	No—measured peer aggression	Behavioral approach
	Lee (2011)	Middle school students	Relational, verbal, and physical	No—only the criteria for peer aggression were met	Behavioral approach
Korea	Lee (2010)	Middle school students	Relational, verbal, and physical	No—only the criteria for peer aggression were met	Behavioral approach
	You et al. (2014)	Middle school students	Rerbal and physical	No—only the criteria for peer aggression were met	Behavioral approach
Taiwan	Wei et al. (2010)	Random sample of middle school students	Verbal and physical	No—only the criteria for peer aggression were met	Behavioral approach
China	Yuhong (2012)	Representative sample of high school students	No	No—measured victimization	Behavioral approach
Spain	Ferrer, Ruiz, Amador and Orford (2011)	Middle and high school students	Relational, verbal, and physical	No—measured victimization	Behavioral approach

Note. [a]Elementary school students: students from first to sixth grade; Middle school students: students from seventh to ninth grade; High school students: students from 10th or higher grade (usually older than 16 years).

evaluation by peers and teachers, and rarely observation and keeping a diary). The biggest issue was a methodological one, that is, in the definition of bullying the criteria of an intention and an imbalance in power was not met, so they actually tested predictors of peer aggression but reported it as predictors of bullying (Bowes et al., 2009; Espelage & Swearer, 2009a, 2009b; Lee, 2010, 2011; Wei et al., 2010; You et al., 2014). These methodological issues make it difficult to compare the findings and especially to come to firm conclusions. Furthermore, in some studies bullying was operationalized only by one item (definitional approach with a distinct definition of bullying), while in other studies aggression had been divided into different types, for example, verbal and physical (Wei et al., 2010; You et al., 2014) measured with the behavioral approach. Also, there was only one longitudinal study (Bowes et al., 2009) and only one study that directly tested the influence of macrosystem variables (Lee, 2011). Other studies actually tried to predict bullying victimization and not bullying per se (Khoury-Kasssabri et al., 2004; Yuhong, 2012).

While there are numerous advantages of using multivariate methods, in the aforementioned studies the authors have not always agreed which variables could have a mediating and which a moderating effect, and generally there has been a fairly small number of studies that explore these effects (except the study of Espelage & Swearer, 2009a). In addition, when using the ecological model, it was not always made clear which variables belong to which level of the model, especially for macrosystem and exosystem level variables, where different authors classified the same variables into different levels of the ecosystem. The studies that had the starting point in ecological theory were mainly carried out in the United States, and only a few in Asia (Taiwan, China, and Korea), while in other cultures (e.g., European cultures, including Croatia) testing the ecological model of bullying or peer aggression has not been done.

Croatia is a good representative example of an Eastern European country, for example, one among countries that have undergone war and had a change of economic policy. In 1991, Croatia declared independence, which led to the Croatian War of Independence that was fought for 4 years following the declaration. Namely, in postwar society violence and aggression may be more often present in the media, as well as considered as more acceptable behavior compared with that in societies that have not seen war for a long time. In addition, Croatia has been going through a transition from socialistic central planning to a free market economy, which has led to changes in the value system from more collectivistic to individualistic and materialistic values. The transition was nontransparent and often criminal as has been depicted in the media. Also, violent and other commercial content have increased as new private media entered the market after decades of exclusively state regulated media. Today, Croatia has a population of 4.28 million, and more than 90% are of Croatian nationality and Roman Catholic. With a long history of education, and today with 55 institutions of higher education, attended by more than 157,000 students, Croatia has a very well developed educational system (99.2% literacy). Since 2013, Croatia has been part of the European Union and today its financial and economic situation (measured by Gini index and GDP—84th place) places Croatia in the middle compared with other countries.

Using the ecological approach for the problem of peer aggression, the study goal was to determine the predictors of peer aggressive behavior among primary school children in Croatia at the four levels of Bronfenbrenner's ecological model (Espelage & Swearer, 2009a; micro-, meso-, and exo-system). The predictors for two different types of aggression, physical and verbal, were tested. In addition, the outcome variables, physical and verbal aggression, were multivariate measures, and consisted of three measures of aggressive behavior toward peers. Although the last level of the ecological model (macrosystem) was not directly tested, the specific characteristics of the Croatian postwar society was discussed in the interpretation of the obtained results.

4 | METHODS

4.1 | Participants

In the current study, a stratified sample was used. Elementary schools from the eastern part of Croatia were split into small and large ones by the number of their students, and then using a random sample, three large and three

small schools were chosen for participation. The participants were students from the fifth to eighth grade from six schools in the eastern part of Croatia. The total number was 880 participants (52% girls) as well as their parents (N = 880, 19% fathers, 61% mothers, and 20% of them who did not check gender). The average age of students was M = 12.8 (SD = 1.15) years, and the age ranged from 10 to 15 years. Students' teachers (N = 107) were also participants (10.2% male, 82.2% female, and 7.6% of them did not check gender).

4.2 | Instruments

4.2.1 | Peer aggression among school children questionnaire (UNŠD; Velki, Kuterovac Jagodić, & Vrdoljak, 2014)

This instrument was designed for self-assessment of peer aggression and victimization based on the behavioral approach, and consisted of two scales (k = 38). The scale of peer aggression among children measures the frequency of aggression committed against peers at school and the scale of peer victimization measures the frequency of experienced aggression at school. The scale of peer aggression among children consists of the subscale of aggression among children in schools (13 items divided into the subscale of verbal aggression [k = 6] and the subscale of physical aggression [k = 7]) and the subscale of electronic aggression (k = 6). For the purpose of the conducted study, only results from the subscale of verbal aggression and the subscale of physical aggression were used. Children indicated the frequency of each committed form of aggression on a 5-point Likert scale where 1 means "*never*," 2 "*rare* (a few times per year)," 3 "*sometimes* (once a month)," 4 "*frequently* (several times per month)," and 5 "*always* (nearly every day)." The result for each subscale is computed as the arithmetic mean of responses to the corresponding items, and theoretically ranged from 1 to 5. The internal consistency for the subscale of verbal aggression was α = 0.77 and for the subscale of physical aggression α = 0.66.

4.2.2 | Peer nomination and self-nomination of peer aggression using the definitional approach (Velki, 2012a)

The sociometric technique of peer nomination and self-nomination of peer aggression based on the definitional approach was applied. The students were given the definitions of three different types of peer aggression (verbal, physical, and cyber) and were asked to nominate the classmates from the name list of their class who behave in the described way more often than the other pupils from the class. It was possible for a student to nominate him/herself for the aggressive behavior. The definition of verbal peer aggression included behaviors such as teasing, gossiping, mocking, insulting, and so forth. The definition of physical peer aggression described a person who punches, pushes, hurts, threatens, and so forth. In addition, the definition of cyber peer aggression was presented. Only self-nomination and peer nomination for physical and verbal peer aggression were used in the study. For peer nomination for each student, the total score was formed based on the proportion of nominations from all the students who filled the peer nomination report.

4.2.3 | Demographic data

Student filled out a special form with demographic data, for example, age, sex, number of best friends, peer acceptance (two items) and school success (six grades: The academic success from the previous grade and term, the final grade in Mathematics and Croatian at the end of the previous school year and at the end of the previous term).

4.2.4 | Empathy questionnaire (Ivanović & Buško, 2008)

The empathy questionnaire measures the degree of empathy for primary school students (from the fifth to eighth grade) and it is divided into two parts (k = 22): affective and cognitive aspects of empathy. The affective aspect of

empathy (k = 10) is defined as the experience of emotion as a reaction to the emotional state of another person and only this subscale was used in the study. Participants indicated their agreement with the described behavior on a 5-point Likert scale where 0, "means does *not apply to me at all*"; 1, "*generally does not apply to me*"; 2, "*neither applies, nor does not apply*"; 3, "*generally applies to me*"; and 4 "*fully applies to me.*" The result for each subscale is computed as the arithmetic mean of responses to the corresponding items, and theoretically ranged from 0 to 4. The internal consistency for the subscale of affective empathy was high, α = 0.79 (k = 10).

4.2.5 | Exposure to the Media Scale (UM; Velki, 2012a)

This self-report scale consists of three items related to the amount of time children spend with media (watching TV daily, playing computer games, and browsing the internet weekly). Students indicated the frequency of time spent with each medium on a 5-point Likert scale where 1 means "*never*," 2 means use of "*less than 3 hr per day/week*," 3 means "*3 to 5 hr per day/week*," 4 means "*6 to 10 hr per day/week*," and 5 means "*the maximum time of use*" (more than 10 hr of watching television per day and more than 10 hr per week for internet and computer games). The total score is obtained as the arithmetic mean of answers to all the items and can theoretically range from 1 to 5. The internal consistency was satisfactory but relatively low, α = 0.66.

4.2.6 | Impulsivity Scale (Vulić-Prtorić, 2006)

The impulsivity scale is part of the wider HIP scale (scale hyperactivity-impulsivity attention) designed to assess hyperactive, impulsive behaviors, and attention problems. HIP is a self-assessment scale, consisting of three subscales (k = 19), on which participants on a 5-point Likert scale (from "*never*" to "*very often*") evaluate the frequency in which the described behavior occurred to him/her in the last 6 months. The result for each subscale is computed as the arithmetic mean of responses to the corresponding items, and theoretically ranged from 1 to 5. For the purpose of the conducted study only, the impulsivity scale (k = 4) was used, and the internal consistency was Cronbach's α = 0.72.

4.2.7 | Parental behavior questionnaire (URP29; Keresteš, Brković, Kuterovac Jagodić, & Greblo, 2012)

The parental behavior questionnaire examines the most common behavior of a mother and father toward a child. There are three versions of the questionnaire, for the mother, for the father, and for the child. Only a version of the questionnaire for a child was used. This version consists of two identical questionnaires, one related to the mother's behavior and the other to the father's behavior. Each of these two questionnaires consists of 29 items. Participants indicated their agreement with the described mother's/father's behavior on a 4-point Likert scale, wherein 1 means "*not true at all*"; 2, "*not very true*"; 3, "*quite true*"; and 4, "*completely true.*" The result for each subscale is computed as the arithmetic mean of responses to the corresponding items, and theoretically ranged from 1 to 4. The questionnaire has a total of seven subscales: Warmth (k = 4), Autonomy (k = 4), Intrusiveness (k = 4), Supervision (k = 4), Permissiveness (k = 3), Inductive Reasoning (k = 5), and Punishment (k = 5). The internal consistency of subscales (Cronbach's α) ranged from 0.70 to 0.86. In the preliminary analysis subscale, permissiveness did not have a significant correlation with verbal (r = 0.059, n.s.) or physical peer aggression (r = 0.064, n.s.) so it was left out from further analysis.

4.2.8 | Scale of perception of neighborhood dangerousness (POS; Velki, 2012a)

The scale of perception of neighborhood dangerousness consists of six items that measure different types of dangerousness to which children are potentially exposed in the neighborhood. POS is a self-assessment scale on

which participants on a 5-point Likert scale (from "*strongly disagree*" to "*strongly agree*") indicate their agreement with the statements. The total score is computed as the arithmetic mean of responses to all items, and theoretically ranged from 1 to 5. Internal consistency was Cronbach's $\alpha = 0.81$.

4.2.9 | Croatian School Climate Survey for students (HUŠK-U, version for students; Velki, Kuterovac Jagodić, & Antunović, 2014)

The Croatian School Climate Survey for students measures a global school climate, that is, the sense of safety and belonging to the school, the relationship between teachers and students, learning atmosphere, parental involvement in school, and predicting the future based on education. It consists of 15 items. HUŠK-U is a self-assessment scale on which participants on a 5-point Likert scale (from "*strongly agree*" to "*strongly disagree*") indicate their agreement with statements. The total score is computed as the arithmetic mean of responses to all items, and theoretically ranged from 1 to 5. Internal consistency was Cronbach's $\alpha = 0.92$.

4.2.10 | Attendance of parents at the parent–teacher meetings and other school events (Velki, 2012a)

To evaluate the frequency of attendance of parents to individual meetings, parent–teacher meetings (PTA), and school events, homeroom teachers were asked to estimate the frequency of parents' arrivals based on the data in the school directory. On a 3-point Likert scale, the homeroom teacher evaluated parents' arrival by circling the corresponding number, wherein 1, "*meant that parents of that child never come*"; 2, "*that parents of that child sometimes come*"; and 3, "*that parents of the child regularly come.*" The total score is computed as the arithmetic mean of two responses, and theoretically ranged from 1 to 3.

4.2.11 | SES of the family

The parents provided data on the SES of the family. Three different aspects related to SES (employment, income, and education level) were measured. The parent who filled out the questionnaire gave the information for him/herself and for the other parent (the child's father/mother). Parents' answer for every aspect of SES was scored from 1 (lowest SES) to 4 (highest SES). The total score was computed as the arithmetic mean of all items ($k = 6$), and theoretically ranged from 1 to 4. Parents gave demographic data about gender and age and also about the age of their partner.

4.3 | Procedure

The ethical commission at the Faculty of Social Science at the University in Zagreb (Study of Psychology) and the ethical commission at the Faculty of Education at the University of Osijek approved the study. Cross-sectional data were collected during the summer school semester, school year 2011/2012. During the teachers' meeting, it was explained how the research would be carried out and the homeroom teachers were asked to prepare a list of students from their class so that the instruments (sociometric procedure) could be prepared. At the next PTA meeting, the main researcher explained the purpose of the research and asked parents for written consent for the child's participation. Parents also gave data about the family SES. Students' data were collected collectively during classes in schools. Before the data collection, students were clearly reminded of the possibility to give up at any time and guaranteed confidentiality of the data obtained in the study. Data collection lasted about 45 min. During students' filling out the questionnaires the homeroom teachers evaluated the frequency of parents' attendance to PTA and other school events.

5 | DATA ANALYSIS

Most of the variables were obtained based on the arithmetic means of the above-described items on the questionnaires and scales. For the variable school success, the average values of the sum of the students' academic success from the previous year and from the previous term were used. The achievements in Mathematics and Croatian (with general academic success at the end of the school year/term) were chosen because in elementary school students mostly have very good to excellent grades. Croatian and Mathematics are usually considered to be basic subjects in the elementary school; therefore, the criteria are more severe in comparison to some other subjects (Vrdoljak & Velki, 2012) and give us insights that are more objective. The index of income inequality was obtained based on families' SES, and has provided a more precise measure of inequality within a particular group, in this case within the class that the child attends.

5.1 | Multivariate–multilevel modeling (MLM)

All the variables met the assumptions for conducting the MLM analysis (variances were not zero, there is no perfect multicollinearity, the predictors were not correlated with external variables, assumptions about normal distribution of errors and linearity were also met).

At the first level of the model, the latent construct or multivariate outcome (measurement model) has been defined, which consists of three measures of aggressive behavior toward peers (self-assessment of aggressive behavior, peer nomination, and self-nomination for aggressive behavior), previously set up to *z*-scores. To facilitate the interpretation, all predictor variables were centered on the overall mean (grand-mean centering method).

At the second level of MLM, variables that vary within a group (i.e., between students) were been defined. These variables are actually predictors measured on the individual level (for every student) and they were tested as different predictors from the theoretical Bronfenbrenner's ecological model: (a) infrasystem: Sex, age, affective empathy, and impulsivity; microsystem-family: parental punishment, parental inductive reasoning, parental warmth, parental autonomy, parental supervision, and parental intrusiveness; (b) microsystem-peers: number of friends and peer acceptance; microsystem-school: school success; (c) exosystem: time spent using media and perception of neighborhood dangerousness. At the third level of MLM, variables that vary between classes were defined. These variables are group-measured variables for student class, meaning that every student in same class had the same value of this variable, but students from different classes differed on these variables. Three variables were tested as predictors of the ecological model: school climate (estimated by the students–microsystem–school), parents' attendance at the PTA meetings and other school events (mesosystem) and the index of income inequality (mesosystem). At the fourth level of MLM, variables that vary between schools (e.g., school policies against bullying and school climate assessed by teachers) were defined (all students from same school have same score on these variables), but the intraclass correlation coefficient (ICC) did not show a statistically significant variation between schools so these variables were excluded from further analysis. Therefore, the model with three levels was tested and the above described analysis was repeated two times using different criteria variables (physical and verbal aggression). Analyses were done on the variance components (VC) of the covariance structure matrix using the maximum likelihood estimation method.

6 | RESULTS

In accordance with the study goal, the significance of the predictors for physical and verbal peer aggression were checked. The results showed (Table 2) that 29.3% (Level 2) of the total variability in physical aggression can be explained by differences among students, while only 4.7% (Level 3) of the total variability can be explained by differences among classes. Although the variability on the third level was less than 5%, Wald *Z* was statistically

significant ($p < 0.01$), and therefore the significance of predictors on the third level was checked. For verbal aggression, 17.8% (Level 2) of the total variability can be explained by differences among students and 9.9% (Level 3) of the total variability can be explained by differences among classes.

The predictors of peer physical aggression explained 47.14% of the variance on Level 2 (between students), but nonetheless a significant 19.08% still remained unexplained. At the third level, 39.47% of variance (between classes) was explained and another 3.54% of unexplained variance (Table 3, VC in Model A) remained.

For verbal peer aggression there was a significant reduction in variance on both levels of the model. On Level 2 (between students), predictors explained 58.41% of the variance, but there still remained a significant 8.79% of unexplained variance. At the third level, predictors explained 46.22% of variance (between classes) and another 6.73% of unexplained variance remained (Table 3, VC in Model A1).

The model fit for multilevel models of peer physical aggression (Table 2) was tested using the χ^2 likelihood ratio test. Comparison of Model A with Model B ($\chi^2 = 26.441$; $p < 0.01$) showed a statistically significant improvement of model fit for Model B. In addition, as Model B was extended, comparison with Model C ($\chi^2 = 7.434$; $p < 0.01$) was done, indicating that Model C is better than Model B. Also other indicators of model fit (AIC and AICC; Table 3) showed a better model fit of Model C compared with Models A and B, so it was decided to choose Model C as the final solution.

Model C obtained the following significant predictors of physical aggression toward peers that explained the variability between students: male, poorer school success, more time spent with media, more impulsive behavior, more parental punishment, and a greater perception of neighborhood dangerousness. Furthermore, the Model C had two significant interaction effects, that is, between negative parental discipline and the perception of neighborhood dangerousness (Figure 1) and between impulsivity and parental supervision (Figure 2). Model C had no significant predictors at the third level, between classes (Table 3).

Figure 1 shows the interaction effect of parental punishment and the perception of neighborhood dangerousness on the second level of the model. In cases where the student perceived great neighborhood dangerousness, the parental punishment is more associated with physical aggression toward their peers, but in situations where students perceive medium or low neighborhood dangerousness, this correlation is weaker.

Figure 2 shows the interaction effect of impulsivity and parental supervision on the second level of the model. In cases where students perceive a low level of parental supervision, impulsivity is more strongly associated with physical aggression towards peers, but in situations where students perceive a medium or great level of parental supervision, this correlation is weaker.

TABLE 2 Estimates of null model of multilevel modeling for criteria variables peer physical aggression and peer verbal aggression

	Parameters	Physical aggression	Verbal aggression
Fixed effects	Intercept	−0.012	0.016
Variance components			
Level 1	Variability in aggression (individual differences)	0.661**	0.728**
Level 2	Variability in aggression within classes	0.047**	0.178**
Level 3	Variability in aggression between classes	0.293**	0.099**
Indicators of model fit	−2 Log likelihood	6022.83	6043.16
	Akaike's Information Criterion (AIC)	6030.83	6051.16
	Hurvich and Tsai's Criterion (AICC)	6030.85	6051.18
	Bozdogan's Criterion (CAIC)	6057.62	6077.96
	Schwarz's Bayesian Criterion (BIC)	6053.62	6073.96

*Note.*** $p < 0.01$.

TABLE 3 Predictors models of multilevel modeling for peer-to-peer physical and verbal aggression

Outcome measures	Parameters	Physical aggression Model A	Model B	Model C	Verbal aggression Model A1
Fixed effects (regression coefficients)	Intercept	0.002	−0.019	−0.033	0.026
Level 2	Gender	−0.219**	−.225**	−.238**	−.020
	Age	0.041	0.038	0.042	0.026
	School success	−0.084**	−0.071**	−0.065**	−0.031
	Affective empathy	−0.061	−0.060	−0.054	−0.077*
	Time spent using media	0.098**	0.104**	0.103**	0.061*
	Impulsivity	0.220**	0.213**	0.206**	0.285**
	Number of friends	−0.006	−0.021	−0.015	−0.034
	Peer acceptance	0.011	0.004	0.003	−0.090*
	Parental inductive reasoning	0.089*	0.090*	0.079	0.066
	Parental punishment	0.106**	0.099*	0.109**	0.149**
	Parental warmth	0.052	0.011	0.003	0.019
	Parental autonomy	−0.131*	−0.112	−0.104	0.024
	Parental intrusiveness	−0.030	−0.040	−0.040	−0.016
	Parental supervision	−0.072	−0.089*	−0.073	−0.120**
	Neighborhood dangerousness	0.201**	0.167**	0.170**	0.115**
Interactions on second level	Parental punishment × neighborhood dangerousness	–	0.222**	0.229**	–
	Impulsivity × parental supervision	–	–	−0.108**	–
Level 3	School climate	0.050	0.051	0.057	0.124
	Parents attendance at the school	−0.016	−0.036	−0.036	0.151
	Index of income inequality	2.242*	2.045	2.029	4.836**
Variance components					
Level 1	Variability in aggression (individual differences)	0.627**	0.628**	0.628**	0.715**
Level 2	Variability in aggression within classes	0.155**	0.141**	0.137**	0.074**
Level 3	Variability in aggression between classes	0.029*	0.029**	0.030**	0.053**
Indicators of model fit	−2 Log likelihood	5545.41	5518.97	5511.54	5640.31
	Akaike's Information Criterion (AIC)	5589.41	5564.97	5559.54	5684.31
	Hurvich and Tsai's Criterion (AICC)	5589.89	5565.49	5560.10	5684.79
	Bozdogan's Criterion (CAIC)	5736.24	5718.48	5719.72	5831.14
	Schwarz's Bayesian Criterion (BIC)	5714.24	5695.48	5695.72	5809.14
Degrees of freedom	Number of parameters	22	23	24	22

Note. **$p < 0.01$.
*$p < 0.05$.

Table 3 shows the final predictor model for verbal peer aggression. For Model A1 data indicated that verbal aggression toward peers can be predicted on the basis of a lower level of affective empathy, more time spent with media, more impulsive behavior, less peer acceptance, more parental punishment, less parental supervision, and perception of greater neighborhood dangerousness. Only one significant predictor was at the third level, index of income inequality, which explains the variability between classes. There were no significant interactions of predictors on the second level of the model, and also there were no significant variation of the second level predictor variables between classes (Table 4), so the final model was Model A1.

7 | DISCUSSION

7.1 | Predicting physical and verbal peer aggression

Numerous studies have dealt with the prediction of bullying (Barboza et al., 2009; Bowes et al., 2009; Cook, Williams, Guerra, Kim, & Sadek, 2010; Lee, 2011), however, only a small number of them have dealt with the predictors of various types of peer aggression such as physical and verbal aggression (Marini et al., 2006; Wei et al., 2010).

From the infrasystem level of Bronfenbrenner's ecological model, male gender, a higher level of impulsivity and lower level of empathy were significant predictors of peer aggression. Consistent with previous studies, gender was a significant predictor of physical peer aggression (Kim et al., 2011; Wei et al., 2010; You et al., 2014) but not of verbal aggression (Archer, 2004; Björkqvist, 2017). In addition, impulsivity was a significant predictor for both types of peer aggression, while affective empathy was a significant predictor of verbal aggression.

Teachers should approach every student individually, taking into account his/her specific characteristics. In accordance with biological theories of aggression, boys, because of a greater amount of testosterone and their genetic predisposition, are more prone to aggressive behavior (Constantino et al., 1993a, 1993b; Mazur & Booth, 1998). Gender-role socialization, especially in stereotypical gender role families, influences boys to exhibit more aggressive attitudes and behaviors (Endendijk et al., 2017). Expression of these aggressive behaviors is predominant in the school environment. In postwar society, boys often hear stories about war heroes; men who showed strength and courage through violence in war (Keresteš, 2002) and especially if children have a male teacher who participated in a patriotic war, children identify with that heroic aggressive behavior (Groebel, 1999). Boys are also four times more often diagnosed with ADHD, especially the impulsive type (Velki, 2012c), and generally express a ower level of empathy (Espelage, Mebane, & Swearer, 2004; Gini, Albiero, Benelli, & Altoè, 2007). Generally, studies have shown that hyperactive children, especially those with significant impulsivity, are more often involved in aggressive behavior and bullying (Velki & Dudaš, 2016; Velki & Romstein, 2016). Impulsive children have a low tolerance to frustration and often react inappropriately (i.e., aggressively) in neutral situations. Furthermore, this is a bigger issue for impulsive children, who have a low tolerance to frustration and often react aggressively in neutral situations, especially if there is a lack of teachers' supervision. In addition, children with lower levels of affective empathy are not able to sympathize with others. They rationalize their aggressive behavior

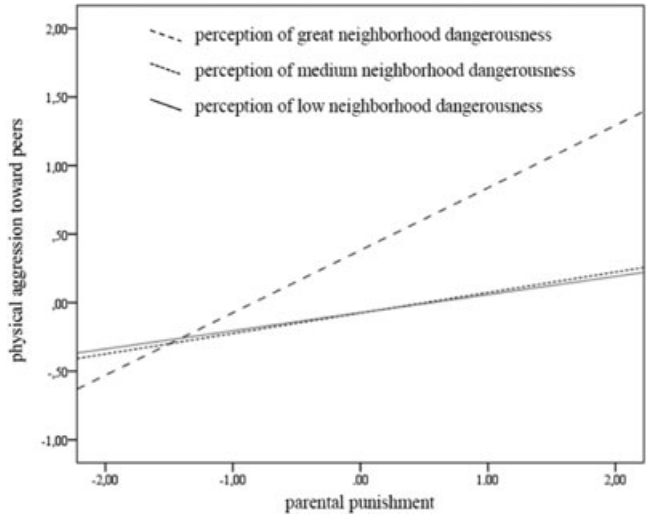

FIGURE 1 Interaction effects between parental punishment and perception of neighborhood dangerousness for physical aggression toward peers at the second level of model (within the class)

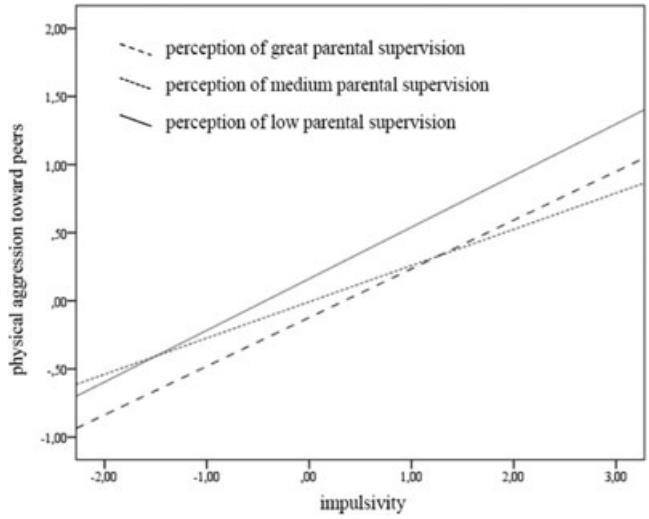

FIGURE 2 The interaction effect between impulsivity and parental supervision for physical aggression toward peers on the second level of model (within the class)

TABLE 4 Variations of predictors from the second level of the model (between students) on the third level (between classes) for verbal peer aggression

Variance components	Variables	Coefficients
Level 1	Variability in aggression	0.713**
$Intercept_2$	Within classes	0.048*
	Affective empathy	0.017
	Time spent using media	0.008
	Impulsivity	0.010
	Peer acceptance	0.019
	Parental punishment	0.00
	Parental supervision	0.00
	Neighborhood dangerousness	0.009
$Intercept_3$	Between classes	0.051**

Note. $^{**}p < 0.01$.
$^{*}p < 0.05$.

as fun without realizing the consequences. The combination of those individual characteristics presents risk behavior for development of aggression in schools.

At the microsystem level, significant predictors of peer aggression were the following: more parental punishment, less parental supervision, poorer school success, and a lower level of peer acceptance. Parental punishment was significant in predicting verbal and physical peer aggression, and parental supervision in predicting verbal aggression. Harsh discipline, especially in families prone to corporal punishment, often borders on abusive parenting behavior, which is a good predictor of aggressive behavior (Bender et al., 2007; Bowes et al., 2009; Gershoff, 2002), and in the conducted study parental punishment (e.g., item *slaps me when I act badly*) indirectly indicates possible abuse. Harsh disciplining of children is considered as a desirable way of upbringing in a traditional society such as Croatia and a study shows that parents believe physical punishment is justified; moreover, 100% of parents of primary school children sometimes physically punish their child (Velki & Bošnjak, 2012). Children learn such aggressive behavior at home and transfer it to school situations in relationships with peers. In families with weak parental supervision, there is neither

control over children's activities, nor the correction of inappropriate behavior and children are more prone to engage in violent activities because they think they will go unpunished (Loeber & Hay, 1997; Yahav, 2007).

Parental supervision also has a moderating role (Figure 1). Impulsive children, due to inability to control their own behavior, often enter a situation of conflict and react violently without thinking. When parents do not supervise and control an impulsive child, the child does not adopt the appropriate form of behavior and does not learn self-control of his/her impulsive behavior, which will lead to the greater expression of aggression (Velki, 2012c). If parents constantly supervise the child and prevent the child's impulsive response on time, consequently the child's aggressive behavior will be reduced as well. Because of the economic crises in Croatia usually both parents need to work and the child is most of the time without their supervision.

Furthermore, peers and school microsubsystems have an important role in school adjustment. Student's grades, as well as peer relations, are an important part of their everyday school life. Consistent with previous studies, poor school success is a significant predictor of physical aggression (Kim et al., 2011; Orpinas & Horne, 2006) while a lower level of peer acceptance is a significant predictor for verbal peer aggression (Asher & Coie, 1990; Snyder, Horsch, & Childs, 1997). Some children with lower academic achievement try to compensate for a sense of incompetence and failure with inappropriate aggressive behavior toward their peers in classroom, but usually their behavior is not approved of either by peers or by the teachers. With aggressive behavior these children are trying to gain status and popularity within the peer group (Rodkin, Farmer, Pearl, & Van Acker, 2000), which presents an additional problem for students and teachers to deal with.

The school also has an important role in the correction of the student's aggressive behavior. Although the school cannot directly influence parental upbringing, it can have a significant role in school–family relations (mesosystem level). A larger difference in family income within the student's class was a good predictor of verbal peer aggression. Numerous studies showed that income inequality within countries, communities, or neighborhoods is a good predictor of aggression, crimes, and bullying (Elgar, Craig, Boyce, Morgan, & Vella-Zarb, 2009). In addition, research in Croatia (Rajhvajn Bulat & Ajduković, 2012) showed that students of lower or higher SES are more aggressive than students who self-estimated themselves to be from average SES families, which schools should take into consideration while organizing classes.

Variables at the distal system (ecosystem) have an indirect influence, through family and school variables, and were found to be significant in the conducted research. More time spent using the media and a perception of greater neighborhood dangerousness have been shown to be significant predictors for physical and verbal peer aggression. Studies have systematically shown that exposure to violence on television is a risk factor for aggressive behavior (Huesmann, Moise-Titus, Podolski, & Eron, 2003; Kim et al., 2011), while playing violent computer games increases aggressive behavior, knowledge about aggression, aggressive emotions, psychological arousal, and decreases prosocial behavior (Barboza et al., 2009; Gentile & Walsh, 2002). Benković and Balabanić (2010) found that information about crime is in the third place in terms of the frequency of publication on Croatian Internet portals. A study on Croatian children aged 10–14 showed that 94% of children watch television everyday mostly alone, and usually programs for adults that contain elements of excitement (Ilišin, 2003). Viewing inappropriate content in the media, especially without adult supervision, lowers the tolerance threshold for aggressive behavior. Studies showed that life in a dangerous community, that is one with a high level of aggression and crime, was a strong predictor of aggression (Bradshaw, Rodgers, Ghandour, & Garbarino, 2009; Kim et al., 2011). In dangerous neighborhoods, children observed conflicts daily (e.g., items such as *in my neighborhood there often occur physical conflicts between adults* and *there are weapons in my neighborhood* confirmed these assumptions) and learnt that violence is an appropriate way to solve problems, especially in postwar societies where the level of violence and use of weapons is usually higher (Groebel, 1999; Keresteš, 2002). In this case, their aggressive behavior toward peers is a survival strategy that they learnt.

In addition, students' perception of neighborhood's dangerousness has a moderating effect (Figure 2). In dangerous neighborhoods, more likely, live families with a common practice of harsh punishment (Buljan Flander & Kocijan-Hercigonja, 2003; Cicchetti & Cohen, 2006), which indirectly teaches children aggressive behavior. It is also possible that in dangerous neighborhoods parents are more concerned about the safety of their child, and therefore are more

prone to corporal punishment as a way of protecting the child. Although punishment is not an appropriate educational method, it still protects children from potentially higher risk (e.g., serious fights in the neighborhood, etc.). Usually, children from the same neighborhood go to the same school, so the teachers should be aware of the potential risk of the neighborhood in which school is located.

The abovementioned predictors better explained variance between students in the verbal peer aggression than in the physical one. In addition, significant variation between classes was explained only for verbal aggression. These results indicate the predominant contribution of the biological and psychological characteristics in the explanation of physical aggression, and parental and schools' variables in the explanation of verbal aggression.

Although it was expected that age would be a significant predictor (older children would be more aggressive), it was not proven. It is possible that age did not show up as a significant predictor because all our students were in the higher classes of primary school (fifth to eighth grade), that is, age homogeneous. In addition, the number of friends was not a significant predictor possibly because, as studies have shown, aggressive children are not lonely and isolated (Pellegrini, Bartini, & Brooks, 1999) and they have friends with similar violent tendencies. Most of the potential parental predictors were not significant maybe because parental variables actually represent the correction of undesirable behavior (parental inductive reasoning and parental intrusiveness) and occur as a consequence of aggression; or because some parental variables are potentially protective factors (parental warmth and parental autonomy) and therefore do not have a key role in predicting peer aggression.

7.2 | Practical implications

The school, as an educational institution, can offer comprehensive prevention and intervention programs, taking into account the children's individual and family characteristics and also the influence of community. As the results show, aggressive children have a lower level of affective empathy, which leads to lack of understanding of the consequences of their aggressive behavior. In addition, impulsive behavior causes a child to respond with violence toward peers very often without thinking. Children with poorer school success and who are not accepted by peers are those at risk for aggressive behavior. For all children at risk, various intervention programs can be organized, for example, role-playing games to increase empathy, techniques for gaining self-control, additional classes and various workshops. However, a better option is the introduction of prevention programs that will have a long-term positive effect on the whole school system (Espelage & Swearer, 2009b). Programs, which are suitable for all students, can increase the level of empathy, self-control and develop prosocial behavior. For example, organizing joint extracurricular activities in which students and teachers have a chance to know each other better. In addition, group activities enable the development of tolerance and equality among children and a sense of acceptance, which ultimately has a positive effect on reducing aggressive behavior caused by social differences between children (Keresteš, 2002; Velki, 2012c). Introduction of such prevention programs takes time in terms of the adjustment period, but in different European studies these programs have proven to be very successful (Olweus, 1993; Swearer et al., 2006). Moreover, school can act as an educational institution for parents too, for example, by organizing extra lectures during parent–teacher meetings or school counseling for the parents. Although in most schools some of these interventions have been introduced, they are often not organized intensively enough, and parents often do not take such interventions seriously (Velki, Bačmaga, & Juka, 2016). It is important to raise parents' awareness of how consequential is proper upbringing of children because without their help and involvement it is almost impossible to achieve long-term progress.

7.3 | Contributions and limitations of the study

The carried-out study has several important contributions. Unlike previous studies in Croatia, this study has applied an integrative ecological approach to the issue of peer aggression. In this way, the proximal and distal effects were tested simultaneously within a specific community. The methodological contribution was in the application of

different approaches (definitional and behavioral) and methods for the measurement of peer aggression (self-assessment, peer nomination, and self-nomination). Furthermore, it has a clear operational definition of a construct of peer aggression, and also of two different types of this, physical and verbal. In addition, data on individual and contextual characteristics were collected from several sources, (i.e., students, parents, and teachers), which gave a more realistic point of view. The practical contribution refers to an excellent starting point for the development of prevention programs that will specifically be aimed at reducing risk factors not only in the community in which the research was conducted but also for other communities that have similar characteristics (e.g., postwar societies).

However, the study also had some shortcomings. Although the selection of schools that participated in the survey was random, all the schools were from one country, and only elementary school students participated (fifth to eighth grade), which limits the result generalization to other student populations. The results showed a slightly higher prevalence of peer aggression in relation to the data from a national sample (Rajhvajn-Bulut & Ajduković, 2012) which is actually a result of the sample selection from a country which was greatly affected by a patriotic war. Another possible limitation of the sample is the small proportion of students' fathers (19%) that participated in study. The study was not anonymous, which could produce socially desirable answers. Some possible pertinent independent variables (e.g., self-concept, mental health, previous history of victimization, subculture, etc.) which could have an influence on child aggressive behavior were not included in the study. Additionally, the last level of the ecological model, the macrosystem, was not tested, although the results were interpreted in accordance with the specific post-war situation in Croatia. Finally, the study was transversal in design.

8 | CONCLUSION

The obtained results are consistent with previous studies conducted in Croatia and worldwide. Most studies of peer aggression and bullying have shown that gender is a significant predictor (Kim et al., 2011; Lee, 2010; Wei et al., 2010; You et al., 2014), but none of them have tested the moderation effect of gender on the prediction of bullying or peer aggression based on an ecological approach. Furthermore, future studies should clearly operationalize whether or not they measure bullying by including all its distinctive characteristics, or peer aggression. Child abuse and neglect proved to be a good predictor of peer violence in previous studies (Bowes et al., 2009; Velki, 2012b), so these variables should be included in future studies. It is also necessary to examine the predictors of other types of bullying, such as relational or cyberbullying. To examine the influence of variables at the macrosystem level, future studies should examine the characteristics of different regions and subcultures and especially crosscultural studies are desirable. In addition, it is preferable to use longitudinal designs.

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Dr. sc. Tena Velki radi kao izvanredna profesorica iz područja razvojne psihologije na Fakultetu za odgojne i obrazovne znanosti u Osijeku te trenutno obavlja i funkciju prodekanice za znanost. Vanjska je suradnica na Fakultetu elektrotehnike, računarstva i informacijskih tehnologija i na Filozofskom fakultetu u Osijeku. Aktivna je članica Hrvatskog psihološkog društva (HPK), članica Hrvatske psihološke komore (HPK), dopredsjednica Društva psihologa Osijek (DPO), članica Hrvatskog udruženja za bihevioralno-kognitivne terapije (HUBIKOT), članica Europske federacije psiholoških udruga(EFPA) te jedna od osnivačica udruge Kluba studenata psihologije Filozofskog fakulteta u Osijeku (PSIHOS). Za značajan znanstveni rad primila je nekoliko priznanja: Fakultet za odgojne i obrazovne znanosti 2015. dodjeljuje joj priznanje za uspješan rad i izniman doprinos djelovanju i ugledu Fakulteta, 2016. primila je i stipendiju UNESCO-a Poljska za osobit doprinos u radu na promicanju prava djece s teškoćama u razvoju, 2017. godine Hrvatsko psihološko društvo dodijelilo joj je priznanje za osobito vrijedan doprinos „Tjednu psihologije u Hrvatskoj“, 2018. godine Hrvatsko psihološko društvo dodijelilo joj je Društveno priznanje „Marulić: Fiat Psychologia“ za osobito vrijedan doprinos razvitku i promicanju hrvatske psihologije, a 2019. godine Filozofski fakultet u Novom Sadu dodijelio joj je nagradu za najbolji znanstveni rad objavljen u posljednje dvije godine. Objavila je niz znanstvenih i stručnih radova te aktivno sudjelovala na više od 60 međunarodnih konferencija. Autorica je i urednica više knjige i sveučilišnih udžbenika: Velki, T. i Romstein, K. (ur.) (2018). *Priručnik za rad s učenicima s teškoćama u razvoju u srednjim školama*. Osijek: Fakultet za odgojne i obrazovne znanosti Sveučilišta J.J. Strossmayera u Osijeku.; Velki, T. (2018, 2. prošireno izdanje). *Priručnik za rad s hiperaktivnom djecom u školi: za učitelje, roditelje i asistente u nastavi*. Jastrebarsko: Naklada Slap.; Velki, T., Ilieva-Trichkova, P., & Topolska, E. (Eds.) (2018). *Children's rights in educational settings.* Osijek: J. J. Strossmayer University of Osijek, Faculty of Education & Ombudsman for Children Croatia.; Ramljak, T., Pakšić, B., Velki, T. i Romstein, K. (2017). *Mapa puta borbe protiv seksualnog i drugih oblika nasilja nad djecom na internetu u Bosni i Hercegovini*. Save the Children in North West Balkans.; Velki, T. i Romstein, K. (ur.) (2015). *Učimo zajedno: Priručnik za pomoćnike u nastavi za djecu s teškoćama u razvoju.* Osijek: Osječko-baranjska županija i Fakultet za odgojne i obrazovne znanosti Sveučilišta J.J. Strossmayera u Osijeku. Nositeljica je i voditeljica Programa osposobljavanja pomoćnika za djecu s teškoćama u razvoju i osobe invaliditetom te poslijediplomskog specijalističkog studija Inkluzivnog odgoja i obrazovanja. Područjem informacijske sigurnosti i rizičnog ponašanja računalnih korisnika aktivno se bavi posljednjih pet godina. Najznačajniji joj je doprinos u tom području izrada mjernog instrumenata Upitnika znanja i rizičnog ponašanja računalnih korisnika (Velki i Šolić, 2014.) te prvog sveučilišnog udžbenika na temu informacijske sigurnosti *Priručnik za informacijsku sigurnost i zaštitu privatnosti* (Velki i Šolić, 2018.) te novog nadopunjenog izdanja 2019. pod nazivom *Izazovi digitalnog svijeta*.

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