

STUDY PROTOCOL

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Promoting active behaviours in schoolchildren using the socio-ecological model in the physical education class: study protocol of the ACTIBESE project

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Abstract

Background The correlation between parental and child physical activity levels has been the subject of significant investigation. Existing research has illuminated this association, particularly emphasising its influence during childhood. However, as children transition into adolescence, this relationship appears to weaken. Despite the recognised importance of parental involvement in promoting physical activity among children, scant attention has been directed towards understanding effective strategies and interventions to bolster this relationship. Consequently, there exists a critical gap in the literature concerning actionable measures to enhance parent-child physical activity engagement during the pivotal stage of adolescence.

Methods The ACTIBESE project aims to assess and intervene in Chilean schoolchildren's active behaviours by examining the influence of personal, interpersonal, and school factors. This study includes a cross-sectional and intervention study involving schools in the Valparaíso and Araucanía Regions, representing urban and rural areas. Participants, divided into children (8–11 years old) and adolescents (12–16 years old), will undergo a comprehensive evaluation, including sociodemographic characteristics, physical activity (PA) levels, parental and peer support, teaching styles of the teachers, and school environment characteristics. In the intervention study, a 5-month continuous training program for teachers will be implemented, focusing on improving teaching styles and enhancing teaching competencies related to physical education and health classes. The research will use mixed models, ANCOVA, and logistic regressions for data analysis, network analysis, exploratory factors analysis, and structural equation modelling.

Discussion Through innovative research methods, interventions involving schoolteachers, and a diverse geographical scope, this project aims to make significant contributions to both the scientific understanding of promoting PA and public policy efforts aimed at improving the health and well-being of school-aged children. The

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ACTIBESE project's multifaceted approach, considering school, family, and peer influences, is well positioned to contribute significantly to promoting AB and addressing the alarming decline in PA levels among Chilean youth.

Strengths and limitations of this study

- The study's outcomes will contribute valuable insights into the complex interactions between school, interpersonal, and personal factors influencing schoolchildren's PA, aiding the development of targeted interventions. This comprehensive approach aligns with the project's goal of fostering a physically active lifestyle among Chilean schoolchildren.
- It is the first intervention to improve physical activity levels that includes parents as protagonists in developing middle-income countries.
- The intervention is carried out by physical education teachers themselves, without the involvement of third parties in the project.
- The project includes a broad understanding of the phenomenon through work with the socioeconomic model, which has been little explored in this area of knowledge.

Keywords Exercise, Intervention, Physical activity, Health, Well-being

Background

Active behaviour

Active behaviour (AB) refers to any form of movement that contributes to overall physical well-being like walking, doing domestic tasks, recreational activities, active games, or practising sports which have been progressively decreasing in schoolchildren worldwide [1, 2]. In this project, AB will be understood as any form of physical activity (PA) that focuses on the intention to engage this important part in 24-hour movement behaviours [3] to improve overall well-being. The 24-hour day comprises a continuum of movement behaviours, including sleep, sedentary behaviour (SB), and PA, ranging from complete rest to vigorous movement. Evidence indicates that combinations—such as high levels of PA, low SB, and sufficient sleep—are linked to positive health outcomes [4]. PA has been associated with many health benefits at all stages of life, especially in the youth [5–7]. To obtain these benefits, it is recommended to follow PA guidelines [8] and for children and adolescents to participate actively and regularly in physical education (PE) classes. However, only a small proportion of children and adolescents meet these recommended levels [9, 10].

Chilean Report Card on Physical Activity for Children and Youth in 2016 and 2018 showed that only three out of ten children and two out of ten adolescents performed sufficient PA, revealing a lack of PA in school and out of school. A potential strategy to reverse this trend is to act within the schools since all Chilean children must compulsorily attend schools from 5 to 18 years old according to the educational law. On the other hand, action plans and policies related to active behaviour (AB), although positively evaluated in Chilean Report Cards, have not produced the expected impact, and adherence to PA recommendations remains far from being achieved [11, 12, 13]. Additionally, the Report Cards indicate that for the 5- to 8-year-old age group, both the assessment and

the available scientific evidence are limited and insufficient concerning active play, active transportation, and the family and peer environment—topics that are all addressed in the present project.

Moreover, as a result of the SARS-CoV-2 (COVID-19) pandemic, physical education classes during lockdown were exclusively conducted online. Evidence shows that this shift has led to various detrimental effects on both mental and physical well-being [14, 15], challenging the public educational system [16, 17]. For this reason, it is very important to study more specifically the reasons for low AB in schoolchildren and how schools may help increase it.

Physical education classes

In the Chilean context, Physical Education and Health (PEaH) is a compulsory subject taught four hours per week from preschool through the fourth year of secondary education. Despite this, students spend only 15.8% of class time engaging in effective physical activity [18]. PEaH is often criticised and held partially responsible for the current health issues affecting Chilean schoolchildren [19], even though physical inactivity is a multifactorial problem. Research indicates that the development and implementation of well-designed PE curricula represent a key opportunity to increase physical activity levels [20], as such improvements have been linked to more time spent being active and less time spent in sedentary behaviours [21]. In this context, the quality of PE can be influenced by various factors, such as teaching style, training, motivation, and curriculum [22, 23]. Teaching styles can be categorized into two main clusters (reproductive and productive) according to the spectrum theory [24]. In the reproductive teaching style, schoolchildren reproduce skills or information demonstrated by or provided to them by the teacher. In the productive teaching style, students play an active role in their learning process [25]

while the teacher acts only as a facilitator. Additionally, this style can improve students' intrinsic motivation and lesson satisfaction [26]. In addition, intrinsically motivated teachers tend to use more productive styles and can contribute more to promoting PA among schoolchildren [27].

PE is an important vehicle for the development of permanent AB, which can be changed by teachers [28].

Socioecological theory

According to Bronfenbrenner [29], individuals, families, schools, and communities combine to shape the environment for the social, emotional, psychological, and academic growth of schoolchildren. The socio-ecological model helps identify opportunities to promote AB by recognizing personal (e.g., sex, beliefs, and attitudes), interpersonal (e.g., parents, teachers, peers), and environmental (e.g., availability of PA equipment, facilities, and public policy) factors that may influence one's ability to be sufficiently physically active [30]. Although 'personal' interventions have been effective, behavioural changes are more likely to occur and be sustained when sociocultural and physical environments support an increase in AB. Not only the school but also the influence of the family, especially of the parents, on the promotion or inhibition of global PA is important [31]. For instance, a positive association between mothers' participation in sports and children's out-of-school PA, has been found [32]. Mothers play a more significant role in planning and organizing children's PA, whereas fathers are more likely to model children's PA [33]. Specifically, being allowed to play anywhere in the neighbourhood, family encouragement, family social support, and family activities have been associated with out-of-school PA in schoolchildren [34]. Parents can provide children with instrumental support for PA, such as organizing PA [35], providing transportation, or paying fees for sports activities [36]. In addition, motivating, encouraging, playing with children, providing instruction, and serving as role models are other types of PA support [37, 38]. As children move through adolescence, they spend increasingly larger amounts of time with their peers and friends than with parents [39], especially in the school context. Peer contact is also essential for the development of protective factors such as participation in PA and socializing through movement [40].

Distilling the problem

School AB, the context of the Chilean PEaH class, and the importance of ecological models at schools have been described above. However, little is known about the influence of PEaH, environment, family, and sociodemographic factors on AB among Chilean schoolchildren. From an actual socioecological theory perspective, it is

crucial to describe these phenomena as they are linked to the educational community. Those in which the other actors of that community (schoolteachers and family) can potentially influence and mediate AB both in school and out-of-school contexts. The description of these interactions in this project could add relevant information to strengthen PEaH and its curricular aims, as well as regulate specific educative actors to improve AB in schoolchildren. Figure 1 shows the variables, factor incomes, and outcomes of the study. Based on the above, this study will determine the school, personal, and interpersonal factors associated with AB in schoolchildren.

Methods/design

Study design

ACTIVE BEHAVIOUR in School Education project (ACT-IBESE) is a project funded by the National Agency for Research and Development (ANID) of the Chilean government (Code N°: 1230801), which seeks to investigate and propose useful tools to increase levels of PA in schools. The project will consist of two parts: a cross-sectional study (first and second years) and an intervention study (third year), for three years. The intervention was registered at <https://clinicaltrials.gov/study/NCT06362655>, Identifier: NCT06362655 on April 8, 2024.

Recruitment

An invitation to participate will be sent to the principals of the participating schools. Once the schools agree to take part and are selected, a meeting will be held with both the representatives of the administrative management authorities and the schoolteachers to explain in detail the aims and stages of the project.

Subsequently, an informative meeting will be held with parents and schoolchildren using the same terms. The groups will be divided by age: children from grades 3–6 of primary school (8–11 years old) and adolescents from grade 7 of primary school to grade 2 of secondary school (12–16 years old). All participating teachers and parents will be required to provide written informed consent before the commencement of the study. In addition, children and adolescents will be invited to provide their assent, ensuring their voluntary participation by ethical standards. Comprehensive information regarding these procedures is detailed in the section on Ethical Aspects.

Intervention study

Objectives of the intervention

The general objective proposed for this project is to examine the personal, interpersonal, and environmental factors that influence the active behaviour of school-aged children, using the socioecological model as a framework for understanding interactions within the school

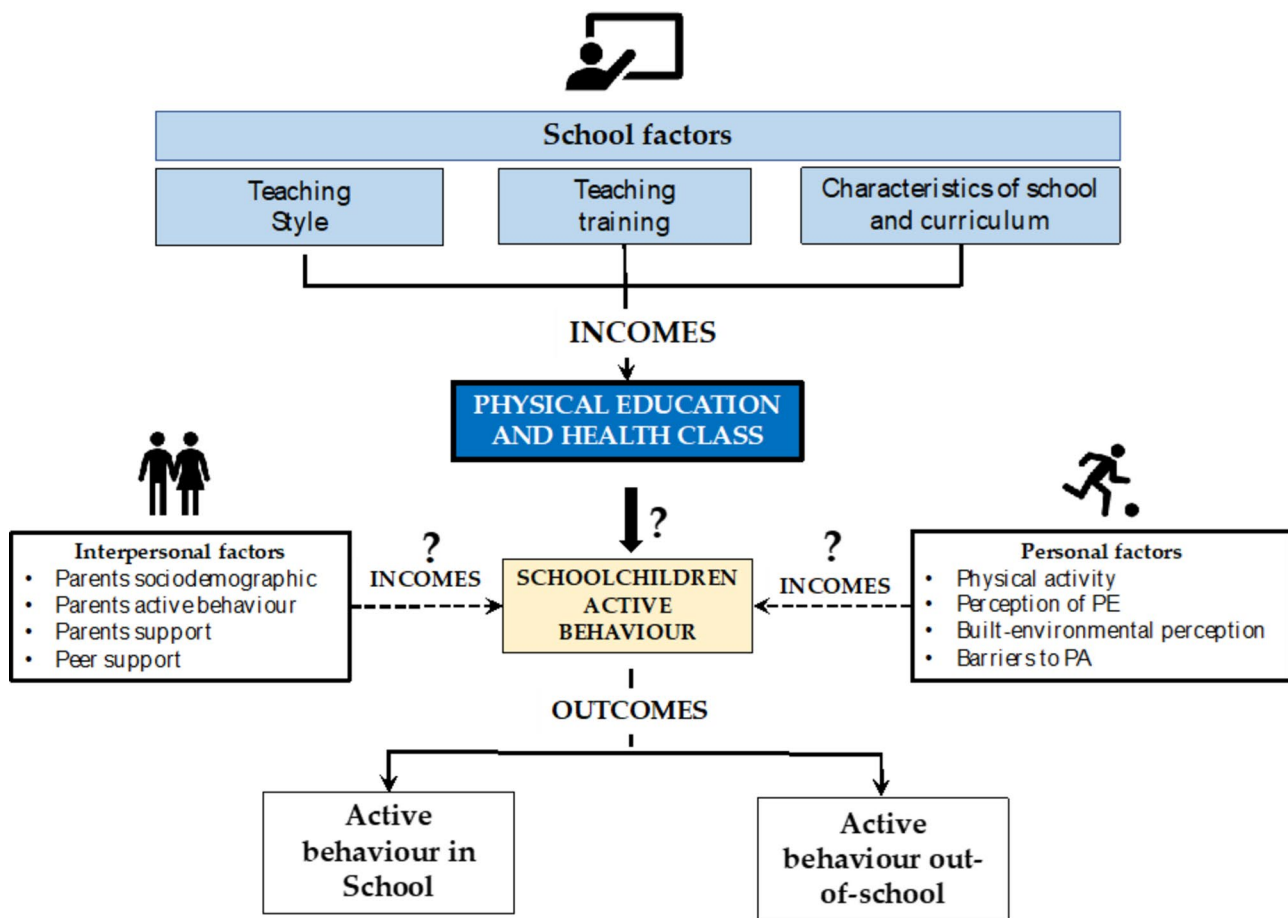


Fig. 1 Interactions and relationships of school, interpersonal, and personal factors with schoolchildren's active behaviour in a cross-sectional study

environment, particularly in physical education and health (PEaH) classes.

The hypotheses associated with the general objective is that “personal and interpersonal factors exert a more significant positive influence on schoolchildren's active behaviour than environmental factors, particularly within the context of schools and PEaH classes”.

As the first specific objective and hypotheses, we defined; a) To evaluate the effectiveness of an educational intervention targeting teachers on increasing student engagement in PEaH classes and enhancing their active behaviour. The hypotheses is that “a school-based educational intervention for teachers, grounded in the socioecological model, will lead to increased participation in PEaH classes and improved active behaviour among schoolchildren”.

The second specific objective is to assess the impact of the intervention on modifying personal and interpersonal factors that influence the active behaviour of schoolchildren. The hypotheses is that “an educational intervention aimed at improving personal and interpersonal determinants of physical activity through the socioecological

model will lead to enhanced active behaviour among school-aged children”.

According to above, the intervention will have three phases (Fig. 2)

a. Assessment: This consists of applying the evaluation instruments to schoolteachers (NSTSS, interviews, and focus group) and schoolchildren (YAP questionnaire, PACO questionnaire, accelerometry, pedometry, and barriers), both in the pre-test and post-test, to the intervention and control groups. In addition, instruments for parents (regarding interpersonal factors) will be used. The pre-test and post-test 1 correspond to the evaluation of the intervention process. Post-test 2 will evaluate the effect of the intervention through a follow-up process.

b. Intervention: The “teaching training” program consists of weekly class sessions addressed to teachers, where topics will be discussed to improve educational practices in PEaH classes. The topic of the teaching training will be: Socioecological model in PA, PA and gender, Active commuting to school, the built environment and PA, Active interventions at the school level, PA and the brain, teaching styles in PEaH, motor literacy and play

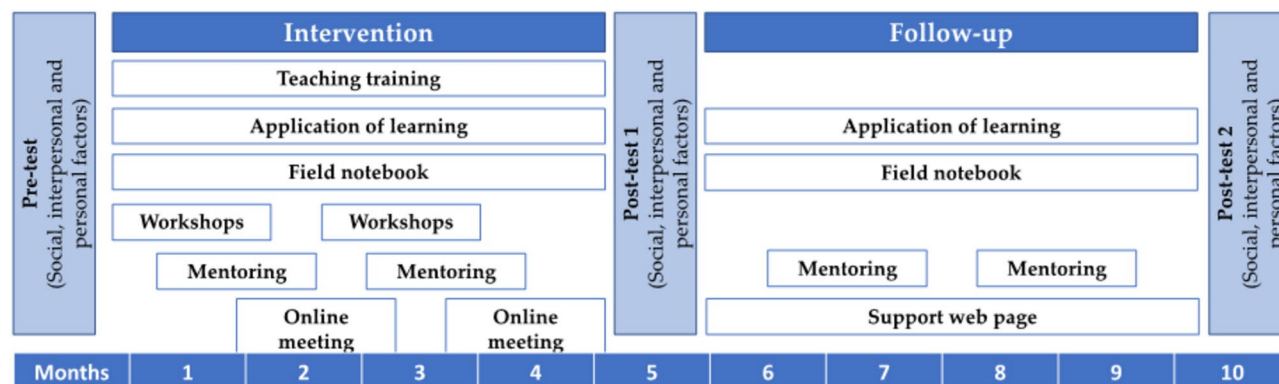


Fig. 2 Activities that will be included in intervention and follow-up Study ACTIBESE

and recreation. These topics incorporate all the actors of the school's educational environment. In addition, strategies are incorporated to stimulate the self-determination theory (SDT). Self-Determination Theory (SDT) is an empirically grounded framework for understanding human motivation and personality within social contexts. It distinguishes between types of motivation based on the degree of autonomy and control, with a focus on the extent to which behaviour is self-regulated or externally influenced [41]. This activity will be conducted in person; however, it will be changed to an online format according to the circumstances of the distance between cities. For the "application of learning" the teachers will begin the initial weeks of the intervention by applying what they have learned during the virtual classes. They will be provided with a foundational guide (Syllabus– Appendix 1) that includes examples of activities, specifying the duration, required materials, and objectives for each task, in order to facilitate implementation in schools. This guide includes initial pre-test assessments, activities designed to promote Active Commuting—such as walks around the school—and instructional strategies for teaching bicycle use (Bikeability). Additionally, it contains strategies for organising active recess periods, adapting teaching styles in PEaH classes, implementing activities beyond the school environment, and involving parents in specific events and commemorative days related to PA within the school context. Parental involvement will occur at various stages of the intervention. One key moment will be during the assessment of physical activity, where parents will wear accelerometers simultaneously with their children, both in the pre-and post-intervention evaluations. This joint activity between parents and children represents a significant component of their participation. Additionally, throughout the intervention, parents will be invited to attend school-based activities, such as family walks and recreational sports events, which are designed to foster engagement and promote active lifestyles within the family context. The application will take

place over a semester (four months) or at least 12 weeks. To assess this implementation, pre-and post-tests will be carried out as defined in the methodology. Additionally, the teachers will keep a "field notebook" consisting of a record of the activities that go wrong or of complex situations that require a solution when the Teaching Training is applied in the chosen courses. Parallel to the problem, a solution or activity must be proposed to solve the difficulties that have arisen. Additionally, in the Teaching Training classes, teachers will be asked to attend various "workshops" on topics associated with AB and PEaH to diversify learning. To strengthen the process of applying these lessons, at least two mentoring sessions will be presented to the PEaH classes to resolve doubts, see the implementation of the changes, and understand the reality that schoolteachers face (Fig. 2).

This activity will be conducted in person; however, if the circumstances prohibit in-person meetings, it will be changed to an online format. In addition, regular "online meetings" will be established for schoolteachers to resolve questions and establish approaches, share ideas and concerns, and jointly resolve difficulties imposed on schoolwork or how to implement the different strategies learned in teaching training. This activity will take place every two weeks.

c. Follow-up: In this phase, teaching materials will be delivered to teachers to be applied during classes. In addition, there will be an observational follow-up to the process, a field notebook will be used, and two process evaluations will be conducted every six weeks from Post-test 1 through "mentoring." Additionally, a support web page will be created with help materials, and an app will be created for schoolteachers and schoolchildren to allow us to monitor the intervention.

Participants and sample selection

The participants will be from two cities in the Valparaíso Region (Viña del Mar and Los Andes) and one city in the Araucanía Region (Temuco). These cities will be chosen

for the convenience of researchers because they are in the region of Chilean institutions conducting the study. Public, subsidized, and private administration schools will be included because, in the Chilean context, schoolchildren are divided into these two groups. The sample includes schoolchildren from rural and urban areas as well as from different social contexts, considering gender equity. A total of 152 schools were identified (Public and Private) and selected based on convenience: 84 in Viña del Mar ($n=25,176$), 19 in Los Andes ($n=7,401$), and 49 in Temuco ($n=21,647$) (<https://reportescomunales.bcn.cl/>). The representative sample size of the students for the cross-sectional study will be calculated at 95% confidence, 5% error, 50% heterogeneity, and a statistical power of 80%.

As a result, out of the 54,224 students that conform to the population, a representative sample of 382 schoolchildren will be obtained by clustering the city, $n=177$ in

Viña del Mar, $n=52$ in Los Andes, and $n=153$ in Temuco. In this cross-sectional study, the participation of three schools in each city (nine schools) will be randomized within each city. Three groups of classes in each school and two teachers from each school will be estimated (men and women equally). In sum, also the total sample is expected to reach schoolchildren, a total of 18 schoolteachers will be considered, where an attrition rate of approximately 20% is anticipated. For the intervention study, another randomization of six schools (one intervention and one control per city), 12 schoolteachers, and 180 schoolchildren will be set up. For the follow-up stage, a sample loss of 20% will be considered, and a final sample of five schoolteachers and seventy-two schoolchildren in each group (intervention and control) will be set up for analysis. Specific samples are shown in Fig. 3.

The groups will be separated by age: children from grades 3–6 of primary school (8–11 years old) and

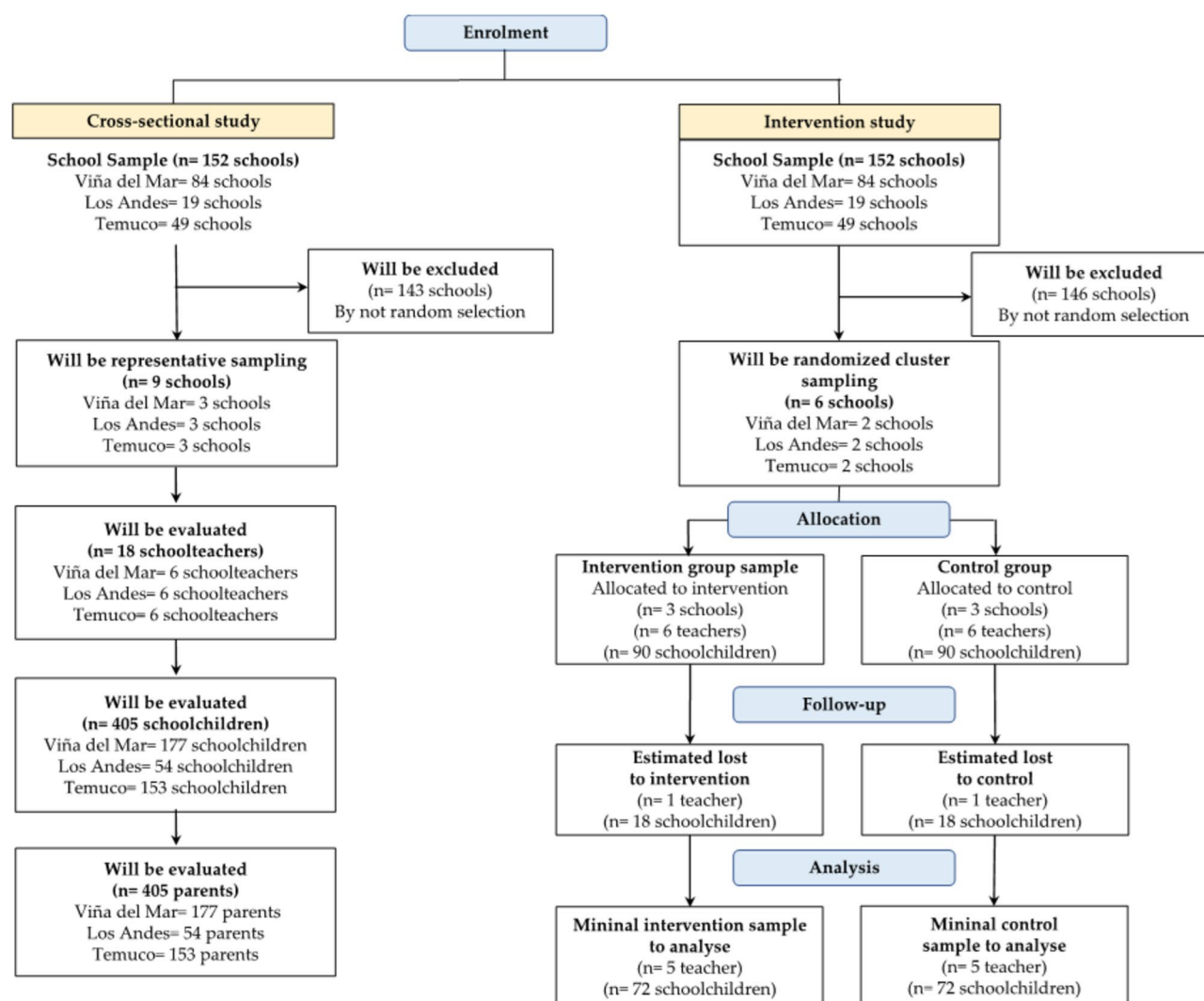


Fig. 3 Plan flow chart for cross-sectional and interventional studies

adolescents from grade 7 of primary school to grade 2 of secondary school (12–16 years old).

The inclusion criterion for schools is that they must have at least two PEaH classes per week, at least in selected grades. Grades between the 4th of primary and the 2nd of secondary will be selected. Each class had to include at least 15 schoolchildren. There must be at least 15 informed consent forms per class for schoolchildren and 15 parents or guardians. Additionally, there must be at least two physical PEaH schoolteachers. Additionally, schoolteachers, schoolchildren, and parents cannot participate in other programs promoting PA.

Instruments

To address the study objectives, instruments will be administered to students to assess the school-related, personal, and interpersonal factors influencing physical activity. Additionally, instruments will be applied to teachers (to evaluate school-related factors) and to parents (to assess interpersonal factors), to strengthen and deepen the understanding of the behavioural network we aim to identify. The timing and organisation of the instrument administration are illustrated in Fig. 4.

Instruments for evaluating school factors

- a. a. For teaching style, the Need-Supportive Teaching Style Scale (NSTSS) will be applied [42], which includes fifteen items that measure task climate support (Items 1 to 5), ego climate support (Items

- 6 to 8), autonomy support (Items 9 to 12) and relatedness support (Items 12 to 15). Responses will be provided on a 5-point Likert-type scale ranging from 1 (“strongly disagree”) to 5 (“strongly agree”).
- b. b. For teaching training, the Evaluation of School Physical Education (ESPE) will be self-reported. The ESPE has questions regarding the contents of the national PEaH curriculum established by the Chilean Ministry of Education [43]. It consists of closed questions in the “Likert scale” (4-point) format, where one is “Disagreeing” and four is “Strongly Agree”. The questions are distributed into eight items that consider the practice of sports, the possibility of alternative activities, the development of body expression, the promotion of PA, the development of activities by the school, the development of self-care, the development of active life, and didactics of the PE class. All dimensions consider only PE within the school context and formal or informal activities at school.
- c. c. For teaching training and school characteristics, interviews and focus groups will be applied. Semi-structured interviews will be conducted with teachers taking part in the intervention study (Table 1). This includes feelings about the contents of school PE, perceptions of their practices as teachers, and opportunities and barriers to carrying out classes.

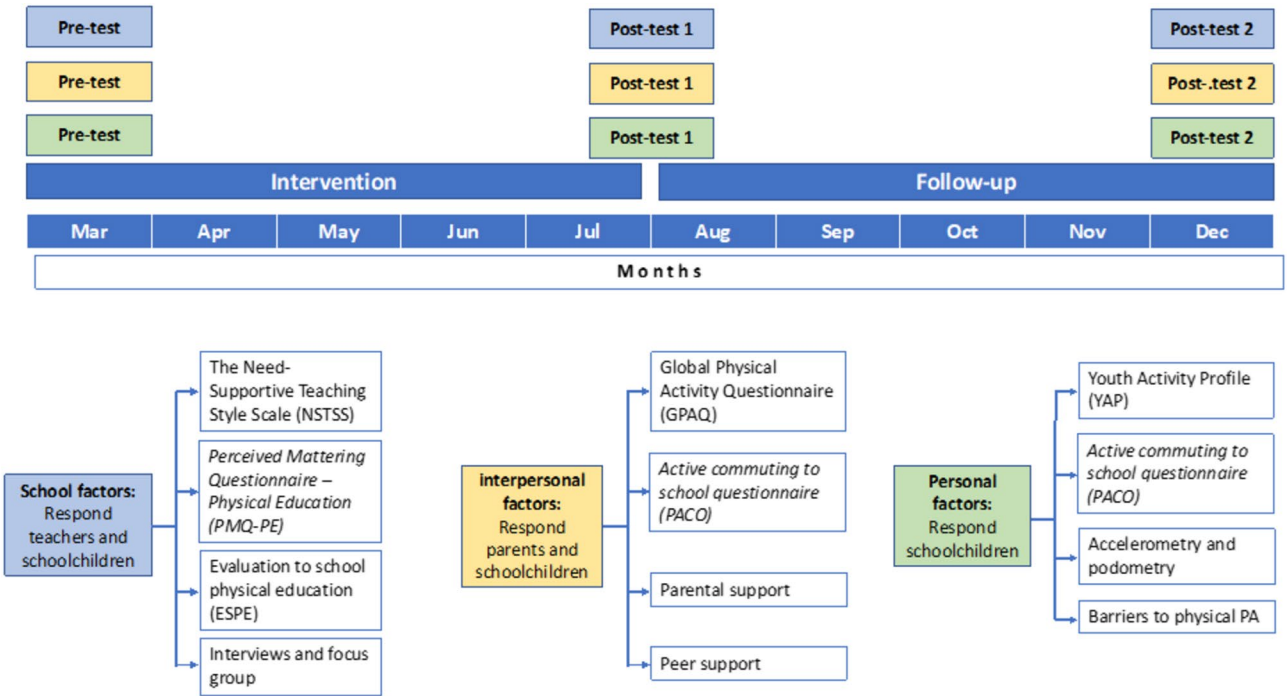


Fig. 4 Types of factors grouped and timing that will be addressed in the intervention

Table 1 Factors, instruments, participants, and stages of application that will be used throughout the project

Factors	Variable	Instrument	Participants	Stage application
School factors	Teaching Scale	NSTSS (38)	Teachers	Intervention
	Teaching training	ESPE (39)	Teachers	Intervention
	Characteristics of school	ESPE (39)	Teachers / Schoolchildren	Intervention
		Focus group/Interviews	Teachers / Schoolchildren	Intervention
Inter-personal factors	Parents sociodemographic	ACTIBESE questionnaire; FAS (40)	Parents	Cross-sectional / Intervention
	Parents active behaviour	GPAQ (WHO, 2004)	Parents	Cross-sectional / Intervention
		PACO (45)	Parents	Cross-sectional / Intervention
		Accelerometer (Axivity AX3) / Pedometer (Yamax EX510 3D)	Parents	Intervention
Personal factors	Parents support	Perceived paternal and maternal support (46)	Parents / Schoolchildren	Cross-sectional / Intervention
	Peer support	Peer Support (36)	Schoolchildren	Cross-sectional / Intervention
	Physical activity	YAP (47)	Schoolchildren	Cross-sectional / Intervention
		PACO (45)	Schoolchildren	Cross-sectional / Intervention
		Accelerometer (Axivity AX3) / Pedometer (Yamax EX510 3D)	Parents / Schoolchildren	Intervention
	For built-environmental and perception PE	ESPE (39)	Schoolchildren	Intervention
	Barriers to PA	Barrier Scale for PA (53)	Schoolchildren	Intervention

Instruments for evaluating interpersonal factors

- The multicomponent ACTIBESE questionnaire was used to obtain sociodemographic and PA variables. Sociodemographic data included sex, age, course, and socioeconomic level using the Family Affluence Scale (FAS III), with questions such as the number of vehicles, household appliances, electronic devices, bathrooms, whether they have their room, and if they travel abroad for vacation [44]. According to the score obtained, it is classified as low level (1–4 points), medium level (5–8 points), or high level (9–12 points).
- The Global Physical Activity Questionnaire (GPAQ) will be used for parents' AB. Having performed an analysis of the validity of the IPAQ (International Physical Activity Questionnaire) and the GPAQ, the latter was chosen as the best option, since it covers more aspects and has similar validity to the IPAQ [45, 46]. The GPAQ was developed by the World Health Organization [47] to collect information on PA and sedentary behaviour at work, activity on the move, and activity in leisure time through 16 closed and open questions (mixed).

According to the GPAQ developers' instructions and standards, physical activities of moderate intensity are considered expenditures of 4 METs, and those of vigorous intensity are considered expenditures of 8 METs. The equation for calculating METs/min/week is $[(P2 \times P3 \times 8) + (P5 \times P6 \times 4) + (P8 \times P9 \times 4) + (P11 \times P12 \times 8) + (P14 \times P15 \times 4)]$, where P is the question, and the attached number is the question corresponding to work,

transportation, or recreation. Question 16 (Q16) corresponds to the time spent on sedentary activities.

Parents will be classified as physically active when they have completed ≥ 150 min/week, meeting the recommendations, and physically inactive when they have not reached 150 min/week, not meeting the recommendations [47].

In addition, an active commute-to-work questionnaire will be used (Table 1). The instrument used to assess the mode of parents' commutes will be a questionnaire from the PACO Study [48]. The questions will be "How do you usually get to work?" and "How do you usually get home from work?" The possible answers are walking, cycling, car, motorcycle, public bus, metro/train, and others (the mode description is required). The mode of commuting will be categorized as "active" (walking and cycling) or "passive" (car, motorcycle, bus, metro/train). Additionally, "passive" commuting will be divided into a private mode of commuting (car, motorcycle) and a public mode of commuting (public bus, metro, train). In addition, the participant will complete the information about the distance and time spent commuting to work.

- Parental support. Perceived paternal and maternal support will be assessed separately using a 5-item scale based on the following question format: "How often does your mother/father do these things?" Responses were based on a 4-point Likert scale ranging from "very frequently" to "never". This relates to encouragement to be physically active and to support PA (i.e., providing transport, watching, and praising PA) and being physically active with their child [49].

- d. Peer support. Peer support will be measured using two items: encouragement to be physically active and being physically active with peers using the following question format: “How often do your friends do these things?”. Answers will be based on a Likert Scale ranging (4-point) from “very frequently” to “never.” Peer socializing will also be measured and quantified using the amount of time spent with friends “after school” and “in the evenings” during the school week.

Participants will be asked, “How many Days a week do you usually spend with friends after school?” and “How many evenings during the school week do you usually spend time with friends?” [40].

Instruments for evaluating personal factors

- a. Three instruments will be used to evaluate PA. First, the Youth Activity Profile (YAP) questionnaire, provides a simple and low-cost method that has already been calibrated and validated to accurately estimate children’s moderate-to-vigorous physical activity (MVPA) and sedentary behaviour at the group level [50]. A Spanish version of the YAP questionnaire was devised using a back-translation process, which is a feasible and reliable questionnaire for Spanish-speaking adolescents. The YAP includes a total of 19 items, including four general items and 15 specific items divided into three sections: 1) Activity at School, 2) Out-of-School Activity, and 3) Sedentary Habits. The final variables to analyse will be an average score ranging from 1 to 5 (lowest to highest) for PA at school and PA out of school, respectively. In addition, PA in children and adolescents will be established by transforming the YAP score to minutes/day in MVPA using the Fairclough equations [51]. The min/day of MVPA at school, out-of-school MVPA, and weekend MVPA will be obtained separately for children, adolescents, boys, and girls. The cut-off points to be “physically active” will be > 60 min/day MVPA [52], which is classified as meeting MVPA recommendations. Those children who did not comply will be considered “physically inactive.” An active commuting to school questionnaire will also be applied. The questions will be the same as those in the PACO Study [48]. The questionnaire has been validated in the Chilean population [53]. In children and adolescents, the questions included in the questionnaire will be “How do you usually get to school?” and “How do you usually get home from school?”. The possible answers are walking, cycling, car, motorcycle, school bus, public bus, metro/train,

and others (the mode description will be needed).

The mode of commuting for schoolchildren will be categorized as “active” (walking and cycling) or “passive” (car, motorcycle, school bus, public bus, metro/train). Additionally, “passive” commuting will be divided into private modes of commuting (car, motorcycle, school bus) and public modes of commuting (public bus, metro/train). In addition, participants will complete questions on distance, time spent commuting to school, and accompaniment. See the details in Appendix 2. Accelerometry and pedometry. PA will be measured objectively with a triaxial accelerometer (Axivity AX3 puck, Newcastle Helix, UK) for ten consecutive days. Schoolchildren will be instructed to use an accelerometer attached to their waist on the right side of the belt. Students will be instructed on how to care for the device, which will be removed during water activities and sleeping hours at night. Schoolchildren will also complete an accelerometry diary to record when it is removed. Axivity software (OMGUI software) will be used for both the initial configuration before the evaluations and for the data dump registered during the evaluation week. In addition, the GGIR R package (Almere, Netherlands) for accelerometer data processing will be used [54]. According to recommendations, accelerometers should be programmed at a frequency of 100 Hz and an EPOCH of 15 s [55]. The final variables to be analysed will be the daily minutes of light, moderate, vigorous, moderate-vigorous, total PA, and Bouts. In addition, accelerometer data will also be extracted from specific times of the day for each participant, calculating the PA during active commuting, in school (physical education lesson, recess, and free time), and out-of-school hours (afternoon and weekend) to identify when changes in PA may have occurred. To obtain time data, participants will carry a pedometer (Yamax EX510 3D Power-Walker Pedometer, UK) on the left side of the belt together with the accelerometer. The device will be removed during water activities and at night. It records up to 30 consecutive days by measuring the number of steps, calories, distance, and time. They will be kept in the custody of their parents during the intervention to stimulate the practice of PA throughout the follow-up period.

- h. For built-environmental and perception PE, school physical education (ESPE) will be self-reported for schoolchildren [43], as previously explained (Table 1).
- c. Barriers to PA. To obtain data on barriers to PA, schoolchildren will complete the Barrier Scale for PA [56]. This is composed of 17 statements that

assess which barriers can negatively influence PA, with seven response levels ranging from “I do not have that problem” to “It is a big problem.” Questions related to the barriers that affect the practice of PA will be categorized into barriers related to time, security, material elements, and capacity for enjoyment. Barriers will be classified as major (> 50%), moderate (25–50%), or minor (< 25%).

Data analysis

Before the analysis, if there is an unintentional random loss of data will be imputed using a nonparametric method using the R package “missForest” [57]. This function successfully imputes large and complex mixed-type datasets (continuous or categorical variables), including complex and nonlinear interactions based on observed values that predict missing values. A Q-Q plot (quantile-quantile plot) will be used to visually verify normality.

Additionally, the interaction between sex and age will be explored. Descriptive statistics for the study variables will be calculated using the mean and standard deviation for continuous variables, and frequency and percentages for categorical variables. The T-test and chi-square test will be used for the continuous and categorical variables, respectively. To establish the association between continuous variables (i.e., PA level), several linear regressions using a standardized coefficient (β) will be used. Associations of dichotomous variables with binary logistic regression models will be performed to obtain the odds ratio (OR) with their respective confidence intervals (95% CI). The results will be analysed according to age (children and adolescents) and sex (girls and boys). To determine the dependence between students within the same school, multilevel logistic regressions that group students will be applied. In addition, network analysis, exploratory factor analysis, confirmatory factor analysis, and structural equation modelling (SEM) will be used to determine the influence of different factors on PA.

The variation between the pre-and post-test results of the interventions will be determined through mixed models, estimating the effect size, analysis of covariance (ANCOVA), and a $2 \times 2 \times 2$ factorial ANOVA. Mediation analysis using the PROCESS SPSS script [58] adjusted for age and sex will be performed.

Multicollinearity will be tested before completing the mediation analysis through the tolerance value and variance inflation factors [59]. The percentage of the total contribution accounted for by mediation using the standardized coefficients will be calculated. A significant “indirect role” (mediation) will be established when (a) the independent variable is significantly related to the mediator, (b) the independent variable is significantly related to the dependent variable, (c) the mediator is significantly related to the dependent variable and (d) the

association between the independent and dependent variable (“direct role”) is attenuated when the mediator is included in the regression model. In both studies, SPSS® v29 (IBM, New York, NY, USA), JASP software (V 0.18.3), and Jamovi version 2.0.0.0 [60] will be used for all analyses. GraphPad Prism software (GraphPad, San Diego, CA, USA) will be used to construct the graphs. Additionally, a $p < 0.05$ value will be established as statistically significant.

Ethical aspects

Once the authorisation of the respective schools has been obtained, parents must sign an informed consent form to authorise their children’s participation in the study. This consent form must include details regarding the nature of the study, its objectives, and the activities to be carried out. On the other hand, students under the age of 14 will be required to sign an assent form, which is a form of agreement that explains, in age-appropriate terms, the characteristics of the study and the activities in which they will participate. Although minors are not legally responsible for providing consent, their assent is necessary to ensure they agree to participate, always under the supervision and authorisation of their parents. Great attention will be given to the distribution of questionnaires for students from single-parent families or those with same-sex parents. Inclusive language, which acknowledges these circumstances, will be carefully integrated into the parent and children’s questionnaires. The project will be developed following the Declaration of Helsinki [61] with the approval of the Bioethics Committee of the Pontificia Universidad Católica de Valparaíso (Code: BIOEPUCV-H 638–2023).

Discussion

Bronfenbrenner’s ecological systems theory [29] provides a framework for understanding multifaceted influences on children’s growth. Notably, the family plays a pivotal role as a crucial microsystem. Parents, particularly mothers, have been identified as significant influencers on children’s PA, with positive associations between maternal sports participation and children’s out-of-school PA [33].

The ACTIBESE project presents an innovative approach to understanding the factors that influence AB in schoolchildren, especially in the context of PEaH classes. This project seeks to uncover new information about the impact of the school environment on the AB of students. Furthermore, it aims to understand how PEaH classes taught by teachers influence this behaviour, shedding light on how the school curriculum impacts both within and outside the school context. In this sense, the project aims to identify areas where curriculum modifications can be made to better align with the promotion

of healthy lifestyles among students. This is crucial for improving the effectiveness of PE classes in achieving their overarching goals related to promoting PA and health.

Additionally, through an intervention study, the project will seek to improve the PE curriculum by identifying the critical components associated with increased AB in students. Doing so, will not only contribute to the scientific literature but also provide inputs to public policies regarding the role of the educational system in promoting PA among students.

The involvement of teachers in the intervention is highlighted as a significant aspect of the project. By providing training to teachers to improve their educational practices, the project will not only benefit the participants but also contribute to the professional development of teachers. This underscores the novelty and potential impact of the interventions proposed in this project.

Moreover, the inclusion of rural and urban areas, diverse social contexts, and public and private schools in the study sample enhances the generalizability of the findings. The intervention study, guided by the results of the cross-sectional analysis, involves a continuous training program for teachers. This program targets teaching styles, competencies, and strategies to improve AB, while considering the socio-ecological model. The study employs a comprehensive set of instruments to evaluate school, interpersonal, and personal factors influencing AB, including teacher perceptions, parental and peer support, and individual barriers. In addition, objective measures such as accelerometry and pedometry provide a robust assessment of PA levels.

While this study makes important contributions to the field of PA promotion in school-aged children, certain methodological considerations must be acknowledged to properly contextualize the findings.

One of the primary limitations of this research lies in the use of self-report instruments to assess PA behaviours and related psychosocial variables. Although self-report measures are widely used in large-scale studies due to their feasibility and cost-effectiveness, they inherently reflect a subjective perspective of behaviour. Responses may be influenced by social desirability bias, recall inaccuracies, or varying interpretations of questionnaire items among participants. These factors may affect the precision of the data collected and should be considered when interpreting the results. Nonetheless, the use of validated and culturally adapted instruments, along with standardized administration procedures, aimed to minimize potential measurement biases and enhance reliability.

A second challenge concerns the role of parents in the intervention. While parental involvement is a key innovation and strength of the study, it also presents an inherent

limitation in terms of control and standardization. Participation by parents is voluntary and largely dependent on their motivation, interest, and availability. This introduces variability in the degree of engagement across participants, which may influence the consistency and overall effectiveness of the intervention. Although strategies such as informational sessions, practical workshops, and communication materials were implemented to foster parental engagement, it is recognized that the project cannot fully ensure uniform participation or influence external factors that may limit parental involvement.

These limitations highlight the complexity of implementing multi-level interventions in real-world settings. However, they also underscore the ecological validity of the study, as it reflects the conditions and challenges that are likely to be encountered in the natural environments where such interventions are intended to operate. Future research should consider complementing subjective measures with objective tools—such as accelerometers or systematic observation—and exploring additional strategies to promote and monitor family engagement more effectively, particularly in contexts where structural barriers may limit participation.

Conclusion

The outlined project presents a comprehensive approach to understanding and promoting physical AB among schoolchildren. Through innovative research methods, interventions involving schoolteachers, and a diverse geographical scope, this project aims to make significant contributions to both the scientific understanding of promoting PA and public policy efforts aimed at improving the health and well-being of school-aged children. The ACTIBESE project's multifaceted approach, considering school, family, and peer influences, is well positioned to contribute significantly to promoting AB and addressing the alarming decline in PA levels among Chilean youth.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12887-025-05719-0>.

Supplementary Material 1

Supplementary Material 2

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Author contributions

The study concept and design were conceived by FRR and assisted in refining the study questionnaires and study design by CCM, PCh, and NAF. FRR, NZC and NAF handle data collection. Analyses will be conducted by FRR, CCM, NZC, CB, JM, and NAF. FRR and NZC prepared the first draft of the manuscript and CCM, PCh, ARG and JBS critically and deeply revised the manuscript. All authors revised and approved the submitted version of the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval

This project has been approved by the Bioethics Committee of the Pontificia Universidad Católica de Valparaíso, code BIOEPUCH-H 638–2023.

Consent for publication

No applicable.

Competing interests

The authors declare no competing interests.

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