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# Influence of physical fitness components on personality factors and risk perception of children and adolescents: a cross-sectional study

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## ABSTRACT

**Objectives** To examine the associations of cardiorespiratory fitness ($VO_2$ max) and muscular strength with indicators related to the risk scale, such as perceived competence, sensation seeking, competitiveness, risk taking and risk perception in sports.

**Design** Cross-sectional study.

**Setting** High schools from the Region of Murcia (Spain).

**Participants** Three-hundred-and-seventeen adolescents participated (mean age: 13.69±1.2 years old).

**Primary and secondary outcome measures** Body mass, body height, Course-Navette test, upper limb strength and psychoeducational factors that determine the propensity towards sports accidents in school children, the Sports Accident Propensity Scale were evaluated. It was performance t-test for independent samples, stepwise multiple linear regression models and a multiple mediation analysis.

**Results** The analysis showed significant differences with respect to sex in height, $VO_2$ max, handgrip strength and in all factors of the questionnaire (p=0.02-<0.01). Adolescents who presented greater $VO_2$ max, strength in the handgrip test and age showed a higher score in factors 1 and 3. Higher scores in factor 2 were associated with better $VO_2$ max and strength in handgrip test. Youngers and better values of strength in the handgrip showed higher score in factors 4 and 5. The mediation analysis with two mediating variables (handgrip strength and $VO_2$ max) showed a significant indirect effect. When handgrip strength and $VO_2$ max were included in the equations, the association between sex and each factor ceased to be significant.

**Conclusion** This study highlights the potential benefits of muscular strength (handgrip) and $VO_2$ max in the perceived risk scale, and the variable of age on this.

**Trial registration number** Clinical trial: NCT05544370 (pre-results).

## STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The main strength of the present investigation was the possibility of carrying out a study relating the propensity of sports accidents with the physical condition of adolescents.
⇒ Face-to-face surveys were used, which made it possible to avoid the bias that commonly involves the use of technology, and all the doubts of the respondents were resolved.
⇒ It should be noted that the sample size was a limitation, as it would be interesting to increase sample size to obtain a higher representation of this sector.

## INTRODUCTION

Numerous benefits of physical fitness for physical, cognitive and psychological health are well known in children and adolescents[1–3] although in some cases, they may also entail a risk of suffering from some kind of injury.[4 5] Roldán-Vendrell[6] indicates that risk is the possibility that a person will suffer a certain injury or accident.[4 7] Sport accidents can have a negative effect not only on athletes, but may also affect three areas, such as people, facilities and equipment or areas related to compliance with the regulations of the sport.[8 9]

A multidimensional analysis is required that takes into account physical, psychological and situational aspects, for the correct study of the causes responsible for sports injuries and accidents,[10] and up-to-date accident data records. Some studies in Spain indicate that injuries and accidents represent 0.8% of physical education (PE) classes, with a slightly higher incidence in males.[11] In Ireland, the study by O'Toole *et al*[12] conducted in two Irish paediatric orthopaedic outpatient departments, indicated that upper limb injuries were the most common type of injury in sports and recreation. Afterwards, the authors O'Connor *et al*[13] found that more than a quarter of school children were at risk of injury each year, and of those who sustained an injury, more than a third would sustain two or more injuries during the year, with the

most common injuries being strains, bruises, sprains and fractures.

Other aspects related to risk propensity are perceived competence, sensation seeking, competitiveness, risk taking and risk perception.[14] In general, Latorre states that children tend to underestimate risks, believe they are invulnerable and in some situations take significant risks in physical-sports practice,[15] making it necessary to strengthen measures to ensure not only the processes of purchasing equipment, but also to ensure their corresponding inspections, proper use and maintenance.

Regarding perceived competence, an athlete's low level of perceived competence was associated with a higher risk of injury,[16] while at the same time, it made them feel less competent for adopting risky behaviours,[17] with it being lower in females.[18–24] Likewise, a relationship has been observed between muscular strength and cardiovascular capacity, and fitness and perceived competence.[25] Regarding sensation seeking, athletes with lower levels of this factor are less likely to take risks,[26] and are also influenced by variables such as personality type, type of sport and gender.[27–30] On the other hand, being older is directly related to lower levels of sensation seeking, and it is therefore believed that this relationship may be related to biological processes.[31] In relation to competitiveness, it may be related to the behaviours that may be dangerous to physical integrity.[10] In addition, high levels of competitive anxiety are associated with an increased risk of injury,[32] and the studies confirmed that boys show higher values of this factor, although it was not related to age.[33–35] Horvath and Zuckerman[36] claim that successful past experiences with risk-taking can lead to a reduction in perceived risk. Finally, regarding the risk perception factor, Kontos[16] indicates that it is associated with a higher risk of injury depending on age, previous experience, perceived competence, personality and gender, with men perceiving less risk than women.[16 17 37–40] In contrast, no differences in risk perception in sports were found between boys and girls.[41]

Some studies have also analysed the relationship between these factors. Kontos[17] found that an overestimation of competence was positively related to risk-taking. On the other hand, sensation seeking influences risk perception, and in this case, risky behaviour and accident rates, being a clear predictor of risky behaviour.[42] With regard to the variables of age, gender and muscle strength in the hands, relationships between them were found in a study of 144 climbers from 22 different countries. The authors stated that grip strength in men is superior to that of women, but no significant differences were detected according to the age of the participants analysed.[43]

Without a doubt, special care must be taken when sports are practiced in facilities with children. As Latorre states, they do not yet have a sufficient capacity to discern and anticipate risks and/or dangers.[15] Furthermore, certain behavioural factors can contribute to unintentional injuries,[44] and even more so in school settings, as research discrepancies have been observed between maintaining the balance between ensuring children's safety and providing them with physically and emotionally stimulating environments.[45] There are numerous studies on physical condition, maximum O2 volume, muscle strength, body composition, among others in children and adolescents, but there is no research where these physical abilities are related to psychological aspects such as Sports Accident Propensity Scale, where variables such as risk perception are analysed. This approach is carried out in order to determine the profiles of the students, to raise awareness of the risks involved in physical and sporting activities at school[40] and to develop appropriate injury prevention strategies.[46 47] The aim of this study was to examine the associations between sex, age and physical fitness components, especially cardiorespiratory fitness and muscular strength, and indicators relative to the risk scale such as perceived competence, search for sensations, competitiveness, assumption of risk and risk perception in sports of youth/adolescents, in order to prevent sports-related accidents.

## MATERIAL AND METHODS

### Study design

This study was conducted in the Region de Murcia (Spain) (online supplemental file 1). Parents or guardians and adolescents were informed about the project, and an informed consent was obtained from all study participants and their parents/legal tutors (online supplemental file 2). All the data collected were treated confidentially and anonymously. The present investigation was conducted in accordance with the Declaration of Helsinki. This cross-sectional study design followed the Strobe Statement (online supplemental file 3). The data from this research are part of a registered clinical trial (NCT05544370 / pre-results).

### Sampling method and sample size

The participants were volunteer adolescents from two high schools from the Region de Murcia. They were aged between 12 and 17 years old (mean age: 13.69±1.2). The inclusion criteria for participating in the study were as follows: (a) being enrolled in one academic year in Secondary School, (b) being present on assessment day and (c) being authorised to participate in the measurements. The exclusion criteria were as follows: having any musculoskeletal, neurological, cardiovascular, metabolic or rheumatic alterations.

In order to establish the sample size and power, Rstudio V.3.15.0 software was used. The significance level was set to $\alpha$=0.05. According to the SD established for $VO_2$ max (mL/kg/min) in previous studies[48] and an estimated error of 1.5 mL/kg/min, a valid sample size of 313 was needed for a CI of 95%. Finally, the sample consisted of 317 adolescents, resulting in an error of 1.437 mL/kg/min. Males represented 48.37% of the sample, while the remaining 51.63% was female.

In addition, the body mass index (BMI) of the students in the sample was similar to those found in the results from the Health Behaviour in School-aged Children (HBSC) survey in Europe and Canada. This implies that the adolescents included in this study were representative of those included for adolescents in Spain as a whole.

### Procedures

The same trained researchers measured the variables using standardised conditions in a single session, from 9:00 am to 12:00 pm from May 2022 to June 2022. The adolescents were instructed to wear lightweight clothes. No warm-ups were performed before the evaluations. Before the examinations, to establish the reliability of the examiner, a double-blind study was performed with 30 participants, obtaining an intraclass correlation coefficient higher than 95%.

### Anthropometry measures

Body mass was measured using a SECA 762 scale (SECA, Germany) and height using a GPM anthropometer (Siber-Hegner, Switzerland). After this, BMI was calculated with the Quetelet Index formula (BMI=body mass (kg)/height ($m^2$).[49]

### Physical fitness measures

The Course-Navette test (a 20 m Shuttle run test) was used to assess cardiorespiratory fitness (CRF) as described previously.[50] The maximum oxygen consumption ($VO_2$ max, mL/kg/min) was estimated from the number of laps performed by the test participants using the equation reported by Leger *et al*[50] ($VO_2$ max=31.025 + 3.238 X − 3.248 A+0.1536 A X, where X=running speed and A=age).

To measure upper limb strength, the participants performed a handgrip strength test. Handgrip strength was measured two times on each arm in a standing position with the arms at the sides. Each participant was asked to squeeze the grip with maximal strength or 3 s alternatively with right and left hands, with the elbow in full extension with 1 min rest between the measurements to avoid local muscle fatigue. The grip span of the dynamometer was adjusted according to the hand size of the adolescent. The maximum score in kilograms for each hand was recorded.[51] A digital grip strength dynamometer was used for this (TKK 5401; Takei Scientific Instruments, Tokyo, Japan).

### Psychological aspects measures

In order to assess the psychoeducational factors that determine the propensity of sports accidents in school children, the Sports Accident Propensity Scale (*Escala de Propensión al Accidente Deporte*, EPAD) was used. This scale is composed of 27 items that describe variables that condition the possibility of having a sports accident. This questionnaire presents a Likert-type scale where 1 means 'strongly disagree' and 6 means 'strongly agree'. It includes items from five different factors: perceived competence; sensation seeking; competitiveness; risk taking and risk perception.[14]

### Patient and public involvement

Patients and/or the public were not involved in the design, performance, reporting or dissemination plans of this research.

### Statistical analysis

The database for this research is available from the corresponding author and are publicly available.[52] Normality analyses were performed using the Kolmogorov-Smirnov test and Mauchly's W-test for sphericity analysis. To establish differences between sexes, a t-test for independent samples was used. The effect size was calculated with Cohen's coefficients. A value higher than 0.8 was considered a high effect, a value between 0.6 and 0.4 was considered a moderate effect, a value between 0.4 and 0.2 was considered as a low-moderate effect and a value lower than 0.2 was considered a low effect size.[53] The following was used to determine the variables to be included in the stepwise multiple linear regression models. To analyse whether there was a correlation between a categorical variable and a continuous variable, Spearman's correlation statistic was used. Pearson's correlation analysis was used to analyse the correlation between continuous variables. To analyse the association between categorical variables in the 2×2 tables, Cramer's V statistical test was applied: and in the 2×n tables, the contingency coefficient, showing the value of the statistic and the p-value. The maximum expected value was 0.707, with r<0.3 indicating a low association, a moderate association was defined as an r value between 0.3 and 0.5, and a high association as r>0.5. Stepwise multiple linear regression models were used to predict each factor according to the variables. In the case that a non-linear multiple regression model provided the best explanation of the variance, as compared with the multiple linear regression models, the best model association between the dependent and independent variables was explored with a curvilinear estimation. The multiple mediation analysis, SPSS macro PROCESS (model 4), was applied with two independent significant mediators (SPSS, Chicago, IL, USA). A classical Baron and Kenny step regression method was used.[54] If the association between dependent and independent variables disappeared after the mediation variable was included, the mediation variable was considered as a complete mediator. The statistical analyses were performed with the IBM SPSS package (V.25.0). The significance level set at p<0.05. In a complementary manner, a generalisability analysis was carried out to verify that the estimated results were reliable and generalisable, with the SAGT V.1.0 software.[55]

## RESULTS

The baseline characteristics of the adolescents are shown in table 1.Table 2 shows the data according to sex and the analysis of differences.

Table 3 shows the linear regression of sex with the factors from the questionnaire. It shows that sex significantly

Table 1 Basic characteristics of the adolescents (n=317)

| Variables | Mean±SD/% (n) |
|---|---|
| Age (years old) | 13.69±1.20 |
| Sex | |
| Male | 48.58 (154) |
| Female | 51.42 (163) |
| Height (cm) | 161.38±8.91 |
| Body mass (kg) | 54.09±11.32 |
| BMI (kg/m$^2$) | 20.63±3.71 |
| $VO_2$ max (mL/kg/min) | 20.86±4.80 |
| Handgrip (kg) | 23.90±6.81 |
| EPAD scale | |
| Factor 1. Perceived competence | 28.73±9.37 |
| Factor 2. Search for sensations | 27.04±8.49 |
| Factor 3. Competitiveness | 13.71±5.21 |
| Factor 4. Assumption of risk | 11.54±5.21 |
| Factor 5. Risk perception | 10.86±4.75 |

%, percentage; BMI, body mass index; cm, centimetres; kg, kilograms; mL, millilitre; N, sample; $Vo_2$ $VO_2$ max, maximum oxygen uptake.

explained all the factors, although it only explained a small percentage of the variance (from 1 to 5.7%).

When incorporating the rest of the variables into the model (table 4), the stepwise multiple linear regression showed that the variables $VO_2$ max, handgrip strength and age, explained most of the factor values. Adolescents who presented a greater $VO_2$ max, greater strength in the handgrip test and greater age showed a higher score in factor 1 (perceived competence) and factor 3 (competitiveness). In relation to factor 2 (sensation seeking), higher scores were associated with better $VO_2$ max and a greater strength in the handgrip test. The students who were younger and had a higher level of strength in the handgrip test showed a higher assumption of risk and a lower risk perception (factors 4 and 5).

Table 3 Linear regression of each factor of EPAD scale by sex

| Variables | $R^2$ | P value | Standardised coefficients (β) |
|---|---|---|---|
| Factor 1. Perceived competence | 0.06 | <0.01 | −0.24 |
| Factor 2. Search for sensations | 0.01 | 0.04 | −0.20 |
| Factor 3. Competitiveness | 0.04 | <0.01 | −0.20 |
| Factor 4. Assumption of risk | 0.02 | 0.02 | −0.14 |
| Factor 5. Risk perception | 0.03 | 0.01 | −0.15 |

The stepwise multiple linear regression analysis did not include sex. When the association between sex and the variables included in the model (handgrip strength and $VO_2$ max) was verified by means of a correlation, we proceeded to the mediation study. The mediation analysis with two mediation variables (handgrip strength and $VO_2$ max) showed a significant and indirect effect. When handgrip strength and $VO_2$ max were included in the equations, the association between sex and each factor was no longer significant (figure 1).

Finally, the analysis of generalisability (online supplemental files 4,5) shows in the first design, a generalisability coefficient of 0.902. This result shows the high reliability

Table 2 Analysis of gender differences

| Variables | Male (n=154) Mean±SD | Female (n=163) Mean±SD | Mean Diff±SD Diff Mean±SD | 95% CI | F | P value | Effect size |
|---|---|---|---|---|---|---|---|
| Age (years old) | 13.73±1.21 | 13.66±1.19 | 0.07±0.13 | −0.19 to 0.32 | 1.28 | 0.61 | 0.06 |
| Height (cm) | 162.61±9.86 | 160.23±7.72 | 2.38±0.98 | 0.44 to 4.33 | 7.63 | 0.02 | 0.27 |
| Body mass (kg) | 54.41±10.61 | 53.91±12.03 | 0.70±0.50 | 1.27 to −2.01 | 3.00 | 0.70 | 0.04 |
| BMI (kg/m$^2$) | 20.40±3.51 | 20.88±3.92 | −0.48±0.04 | −1.30 to 0.34 | 2.19 | 0.25 | 0.13 |
| $VO_2$ max (mL/kg/min) | 21.76±4.44 | 20.03±4.98 | 1.73±0.55 | 0.64 to 2.82 | 0.32 | <0.01 | 0.37 |
| Handgrip (kg) | 25.66±7.70 | 22.12±5.31 | 3.54±0.74 | 2.09 to 5.00 | 19.66 | <0.01 | 0.54 |
| EPAD scale | | | | | | | |
| Factor 1. Perceived competence | 30.99±9.03 | 26.53±9.22 | 4.46±1.03 | 2.43 to 6.50 | 0.02 | <0.01 | 0.49 |
| Factor 2. Search for sensations | 28.08±8.67 | 26.06±8.24 | 2.02±0.96 | 0.13 to 3.91 | 0.46 | 0.04 | 0.24 |
| Factor 3. Competitiveness | 14.70±5.03 | 12.76±5.23 | 1.95±0.58 | 0.80 to 3.09 | 0.09 | <0.01 | 0.38 |
| Factor 4. Assumption of risk | 12.25±5.53 | 10.84±4.81 | 1.41±0.59 | 0.26 to 2.57 | 3.05 | 0.02 | 0.27 |
| Factor 5. Risk perception | 11.59±4.71 | 10.14±4.70 | 1.02±0.42 | 0.19 to 1.85 | 0.07 | 0.02 | 0.31 |

%, percentage; BMI, body mass index; cm, centimetres; Diff, differences; kg, kilograms; mL, millilitre; N, sample; $Vo_2$ max, maximum oxygen uptake.

Table 4 Stepwise multiple linear regression analysis of the relationship of each factor of the EPAD scale with independent variables

| Dependent variable | | $R^2$ | P value | Included independent variables | β | P value |
|---|---|---|---|---|---|---|
| Factor 1. Perceived competence | Model 1 | 0.18 | <0.01 | $VO_2$ max | 0.42 | <0.01 |
| | Model 2 | 0.34 | <0.01 | $VO_2$ max | 0.82 | <0.01 |
| | | | | Age | 0.57 | <0.01 |
| | Model 3 | 0.37 | <0.01 | $VO_2$ max | 0.71 | <0.01 |
| | | | | Age | 0.42 | <0.01 |
| Factor 2. Search for sensations | | | | Handgrip | 0.19 | <0.01 |
| | Model 1 | 0.06 | <0.01 | $VO_2$ max | 0.24 | <0.01 |
| | Model 2 | 0.11 | <0.01 | $VO_2$ max | 0.24 | <0.01 |
| | | | | Handgrip | 0.22 | <0.01 |
| Factor 3. Competitiveness | Model 1 | 0.06 | <0.01 | Handgrip | 0.25 | <0.01 |
| | Model 2 | 0.11 | <0.01 | Handgrip | 0.24 | <0.01 |
| | | | | $VO_2$ max | 0.21 | <0.01 |
| | Model 3 | 0.15 | <0.01 | Handgrip | 0.16 | 0.13 |
| | | | | $VO_2$ max | 0.45 | <0.01 |
| | | | | Age | 0.34 | <0.01 |
| Factor 4. Assumption of risk | Model 1 | 0.08 | <0.01 | Handgrip | 0.29 | <0.01 |
| | Model 2 | 0.10 | <0.01 | Handgrip | 0.34 | <0.01 |
| | | | | Age | −0.14 | 0.03 |
| Factor 5. Risk perception | Model 1 | 0.05 | <0.01 | Handgrip | 0.22 | <0.01 |
| | Model 2 | 0.06 | <0.01 | Handgrip | 0.27 | <0.01 |
| | | | | Age | −0.13 | 0.04 |

B, standardised coefficients.

of the test. In addition, the percentage of variance (see online supplemental file 5) was found to be high.

## DISCUSSION

The aim of this study was to examine the associations of sex, age and physical fitness components, especially CRF and muscular strength, with indicators relative to the risk scale, such as perceived competence, search for sensations, competitiveness, assumption of risk and risk perception in sports of youth/adolescents, in order to prevent sports accident.

With regard to the influence of sex on the indicators related to risk propensity, men had a statistically significant higher propensity in all the dimensions of the EPAD scale analysed as compared with the women, as in a previous study,[14] in which this variable was highlighted as one of the determinants of risk behaviour.[56] Specifically, in relation to perceived competence, adolescents with a high estimation of their abilities would be more likely to adopt risky behaviours, as compared with others with a low estimation,[17] with this being higher in men in almost all related studies,[21 24 57–61] although Kontos[16] found no sex differences in self-perceived ability. In this regard, men tend to overestimate their competence while the opposite is true for women,[62] a fact that is also reflected during childhood, where overestimation of one's physical abilities represents a risk factor for everyday injuries, with boys being more at risk than girls.[63] Regarding sensation seeking, the present research coincided with other studies in highlighting higher values in men,[14 24 64–67] which was also accentuated with age.[65 68 69]

These differences may be driven by both biological and socialisation factors.[31] Those with lower levels of sensation seeking try to avoid taking risks,[26] so in this case, women may be less predisposed. In this regard, previous research highlights that boys more often attribute their injuries to bad luck, leading them to experience repetitive injuries, while girls attribute injuries to their own behaviours, causing them to alter their behaviour in future situations to avoid them.[56 70] In relation to competitiveness and the influence of gender, the level was higher in men than in women, with results similar to previous studies.[10 33–35 67] The results referring to risk-taking showed higher values in males,[16 17 37] and these differences may increase when considering physical skills.[37] This could be due to gender-specific sport socialisation, with females focusing their training on skill development, and males on strength development, physical preparation and aggressiveness.[71 72]

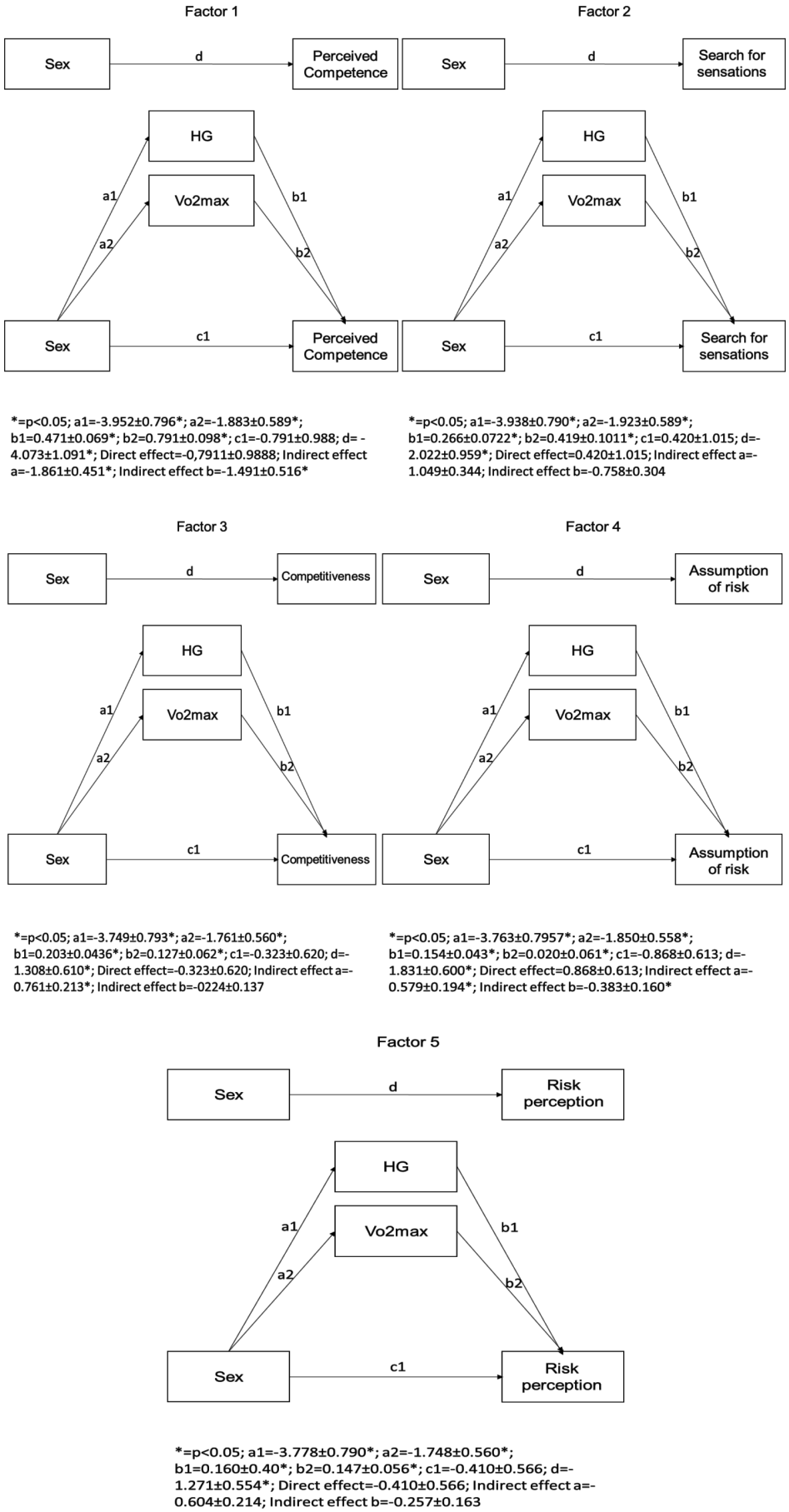


**Figure 1** Simple mediator effect of multiple mediators of two mediation variables.

During adolescence, individuals are more susceptible to risk-taking, and therefore, to injury, with the percentage being higher in males.[17] Moreover, at this stage, other individual characteristics such as age, experience or temperament[56 73] may influence children's decision-making and therefore participation in risky activities. Finally, regarding risk perception, it was higher in females than in males, as in previous research,[16 17] although some studies found no gender differences.[41 74] The differences found may be based on psychosocial factors associated with the predominant male stereotype for boys in sports, as girls are taught to be wary of risks and boys are taught to accept them.[75] This is reflected in a greater male liking for risky sports as compared with females.[74] However, risk perception is also affected by other internal factors such as age, previous experiences, perceived competence, and personality.[40]

Although most previous research focused on sex as a predictor of risk propensity, in the present study, a multiple regression analysis highlighted a significant indirect effect of other mediating variables ($VO_2$ max, handgrip strength and age), which explained most of the factors analysed. However, this may be due to biological sex differences during adolescence, which may influence young people's perceptions and behaviours,[72] with significantly higher $VO_2$ max[76] and handgrip strength values detected in males. More specifically, higher values of $VO_2$ max, handgrip strength and an older age, were related to higher perceived competence and greater competitiveness. In relation to sensation seeking, higher values were associated with better results in the $VO_2$ max value and handgrip strength test. Finally, younger adolescents with a higher strength in the handgrip test showed higher risk-taking and lower risk perception values. $VO_2$ max levels may therefore positively influence optimism, which plays an important role in self-regulation and adaptive behaviour in children and adolescents,[77] with higher $VO_2$ max values being associated with a greater perceived competence.[58 78]

Regarding handgrip strength, as a variable related to muscular strength, the results followed the line of previous benchmark research, in which muscular strength was associated to a higher self-esteem,[2 58 79] self-perception,[2] optimism[79] and perceived competence.[58] This is especially relevant during the adolescence, with substantial differences in the development and attainment of strength, agility and motor skills concomitant with variations in body size.[80]

Finally, age emerged as a predictor of perceived competence, competitiveness, risk-taking and risk perception. This evidence may be based on a possible direct relationship between biological factors, such as age and body size and risk behaviours in young athletes and adolescents,[17] with certain sociodemographic variables such as age being among determinants of risk behaviour[56 81] and the detection of an increase in risk behaviours at ages 12–17 years old,[17] detecting within this stage that 15-year-olds show better inhibitory control than 12-year-olds, while 17-year-olds show a better perspective than younger adolescents.[82] In this regard, López-Araujo and Osca[83] indicated that young people were characterised by underestimating the possibility of suffering certain risks, did not perceive them holistically, detected them more slowly, and tended to overestimate their skills.

Regarding risk-taking, Kern *et al*[84] found that among skateboarders, age was one of the significant explanatory variables, with young people being more likely to take risks than adults, as there was a sense of invincibility and greater impulsivity in youth than in adults. This could be conditioned by hormonal influences, in particular the increase in testosterone and oestradiol during adolescence, which are associated with an impulsive personality, increased risk-taking behaviour and impulsive personality.[85] The results obtained in several investigations are in line with the highlighted age-related differences in risk perception in sports, which makes adolescents more likely to take risks than adults.[78–80] At these ages, participants in school sport activities, depending on their perception of risk, will decide whether or not to take the risk, which is a relevant factor in explaining how they cope in these situations and a topic to be considered in the safety of the PE lessons.[15] Therefore, education for safety in sports should aim at ensuring that children know how to identify sources of risk, that they acquire an adjusted perception of the level of risk associated with it, and that they develop strategies to avoid them.[86] Furthermore, some studies highlight the idea that as children become older, their perception of their own motor competence becomes more accurate, and they therefore tend to have a more realistic estimate of their abilities.[87] In addition, fear caused by natural inhibition dependent on age and maturational stage is reduced as the child experiences a motivating emotion and learns to master appropriate challenges.[88] However, Kontos[17] and De Meester *et al*[23] indicated no significant differences in the perception of risk of injury in sports according to age. Similarly, the period from late childhood to adolescence is characterised by multiple physical, psychological and social changes,[89] with age influencing physical fitness, and with all the fitness components expected to improve from childhood to adolescence,[90 91] in particular, $VO_2$ max.[92 93]

With regard to the conclusions reached in accordance with the objectives of the present research, men have a higher propensity towards risk in all the variables analysed. However, sex was not found to be an explanatory factor for risk propensity when including $VO_2$ max, handgrip strength and age, which explains most of the factors analysed. In particular, a higher $VO_2$ max, a higher handgrip strength and being older showed higher scores in factor 1 (perceived competence) and factor 3 (competitiveness). In relation to factor 2 (sensation seeking), higher scores were associated with better $VO_2$ max and higher handgrip strength. Younger students with a higher level of strength in the handgrip test showed a higher assumption and a lower risk perception (factors 4 and 5).

However, there are other sources of variation, in addition to those studied in this research, which are closely related to the aforementioned constructs, and which should also be taken into account when preventing sports accidents. One of them is the type of sport practised, finding that those who choose to practice risky sports have higher levels of competitiveness, lower risk perception and greater sensation seeking.[94 95] Another factor to take into account is the personality of the subject. In this respect, previous research has associated a personality with low conscientiousness, low agreeableness, less cooperative and high neuroticism with higher risk-taking and participation in risky sports.[26 96–100] In addition, emotion dysregulation was also associated with increased risk-taking.[101 102] Finally, situational factors such as the influence of the group or the time urgency of the situation may distort the perception of the objectivity of the risk,[15 103] as well as the subject's previous successful experiences, reducing perceived risk and increasing risk-taking.[36]

This study is not without limitations. The cross-sectional design of this study is one of the first limitations that does not allow establishing causal relationships; thus, longitudinal studies are necessary. In addition, the method used to assess CRF was the Course-Navette test. Although this method is used in most studies, and is valid and reliable for children and adolescents,[50] this is an indirect method with limitations in its interpretation. The importance of the results obtained in the present research lies in the fact that a positive relationship between risk behaviours and injuries was found,[17] so it is necessary to investigate the variables that can influence them in order to prevent injuries during adolescence. In this regard, health-related fitness was the strongest predictor of future physical activity in the transition from primary to secondary school,[104] and given its relevance, its analysis as a possible predictor variable of risk behaviours is warranted.

## CONCLUSIONS

This study mainly highlights the potential benefits of muscular strength (handgrip) in all indicators of the risk perception scale, the CRF ($VO_2$ max) in three out of five components of the risk scale (ie, perceived competence, search for sensations and competitiveness), and the variable of age in all the factors, except for sensation seeking.

Therefore, it is essential to carry out actions aimed at the entire education community to raise awareness about the possible contingencies caused by poor planning, as well as training and awareness of good practices regarding the use of sports materials and equipment.[7 82]

Some strategies for the future could be as follows:

- To plan this work as a longitudinal study.
- To use go to another assess CRF assessment test to compare with the Course-Navette.
- To compare the results obtained which other risk perception tests.
- It is important to contact health centres to analyse the type of paediatric injuries and compare them with results from other countries.
- To conduct a pilot study on the analysis of children's injuries during one school year in different primary schools.

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