[Physical Therapy]

Physical Activity–Related Injury Profile in Children and Adolescents According to Their Age, Maturation, and Level of Sports Participation

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Background: Physical activity (PA) is beneficial, enhancing healthy development. However, one-third of school-age children practicing sports regularly suffer from an injury. These injuries are associated with sex, chronological age, and PA level.

Purpose: To identify the importance of age, PA level, and maturity as predictors of injury in Portuguese youth.

Study Design: Descriptive epidemiological study.

Level of Evidence: Level 3.

Methods: Information about injury and PA level was assessed via 2 questionnaires (LESADO RAPIL II) from 647 subjects aged 10 to 17 years. Maturity offset according to Mirwald (time before or after peak height velocity) and Tanner-Whitehouse III bone age estimates were used to evaluate maturation. Binary logistic regression and gamma regression were used to determine significant predictors of injury and injury rate.

Results: Injury occurrence was higher for both sexes in recreational, school, and federated athletes (athletes engaged in sports that are regulated by their respective federations, with formal competition). These injuries also increased with age in boys and in the higher maturity offset group in girls. Injury rate was higher for both sexes in the no sports participation group. Early-maturing girls, with higher bone age and lower maturity offset, showed higher injury rate.

Conclusion: Injuries in Portuguese youth were related to PA level, age, and biological maturation. Recreational, school, and federated athletes had more injury ocurrences while subjects with no sports participation had higher injury risk. Older subjects had more injuries. Early-maturing girls that had just passed peak height velocity may be particularly vulnerable to risk of sports injury because of the growing process.

Clinical Relevance: Increased knowledge about injury with specific PA exposure data is important to an overall risk management strategy. This study has deepened the association between injury and biological maturation variables.

Keywords: injuries; children; adolescents; bone age; peak height velocity; physical activity level

General reviews and analysis of trends in sports and physical activity (PA) demonstrate that active young people are more likely to show both immediate and long-term health and wellness benefits.[1,7,45] These advantages help to promote PA and competitive sport by children and adolescents.[7,18,22] This heightened interest in PA has resulted in an increase in sports-related injuries during practice and competitions.[7,18,30,36] Likewise, more than one-third of school-age children will sustain an injury severe enough to require treatment.[1]

The pediatric age group incurs a variety of injuries in numerous sports with sex, age, mechanism, location, injury

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The authors report no potential conflicts of interest in the development and publication of this article. Lara Costa e Silva was supported by a scholarship from the Portuguese Foundation for Science and Technology (SFRH/BD/77408/2011), and by the Interdisciplinary Center for the Study of Human Performance (CIPER).
DOI: 10.1177/1941738116686964

type, and sport-specific differences.[45] The majority of injuries are mild strains, sprains, and contusions, with few severe enough to require hospitalization but still have a significant impact.[17,22] Injuries may lead to dysfunction and reduced participation in sport and fitness activities, thus contributing to the childhood obesity epidemic and school absence,[16,22] and they may disrupt potential benefits of sport.[37] Injury has direct costs from evaluation, treatment, and rehabilitation and indirect costs with lost productivity if parents miss work to attend to an injured child.[17] In addition to the physical and financial costs, injured athletes experience negative psychological consequences including mood disturbance and lowered self-esteem.[18] Predisposing factors for injury include sports practice, morphological characteristics, age, and movement pattern.[18] Children and adolescents are not small adults in their response to exercise and stress.[27] There are physical and physiological differences between children and adults related to growth and development that may cause children to be more vulnerable to injury.[1] Factors that may contribute to this difference in vulnerability include the growth spurt; maturity-associated variation; imbalance between strength and flexibility; structural laxity; bone, cartilage, joints, and muscle-tendons stress vulnerability; and lack of motor and cognitive skills needed for certain sports.[1,10,22,40] In addition, promising young athletes are often exposed to high-intensity training, initiating specialization in their sports at a very early age.[22] Moreover, pressure to perform can play an important role in injury risk. These factors are associated with acute and chronic injury.[27] Thus, overuse injuries, which are traditionally described in more mature athletes, are now becoming recognized in adolescents.[10,11,20] The immature musculoskeletal system is less able to cope with repetitive biomechanical stress.[30] Demands of PA appear to overlap with growth and maturation,[40] and as a result, vulnerability for injuries can temporarily increase. Therefore, it is desirable to identify the importance of age, PA level, and maturity as predictors of injury in Portuguese children and adolescents.

METHODS

The research protocol was in accordance with the Helsinki Declaration for scientific research involving human beings, and was approved by the Ethics Committee of the Faculty of Human Kinetics, University of Lisbon. Before inclusion in the study, all subjects' guardians gave their written informed consent.

A total of 647 children and adolescents of both sexes, aged between 10 and 17 years, attending 4 major schools of Lisbon and involved in different groups of sports participation were selected. A self-reported questionnaire (LESADO) was used to collect information about injuries; the form was adjusted and based on injury surveillance research and questionnaires used in epidemiological studies.[2,18,35] The final questionnaire was divided into 4 components: personal data, characterization of the PA, characterization of training conditions, and characterization of the injuries. Injury was defined as any musculoskeletal condition or symptom that occurred as a result of participation in an organized practice, competition, or physical education class and entailed at least 1 of the following consequences: (1) resulted in PA restriction for at least 24 hours, (2) did not result in time lost from sports participation but determined changes in performance either in quantitative or qualitative terms, or (3) required medical attention by a health professional.[6,21,44] The time frame used was 6 months (September 2011 to March 2012), as recommended in retrospective studies.[16,37] Valid and reliable information about injury in children can be obtained through a self-report survey.[39] It is widely accepted that children aged ≥10 years can realiably and accuretaly self-report information and behaviors.[12,39,46] Neverthless, children younger than 12 years may require assistance to complete the survey[39] to prevent bias and interpretation difficulties. All subjects were followed by the investigator in completing the questionnaires.

The Biosocial Questionnaire RAPIL II was used to determine the biosocial profile. Several investigations with Portuguese samples have made use of this instrument.[15,28,47] It has been used to collect personal, academic, socioeconomic, and family-related information, as well as to evaluate daily PA habits of the subject. The instrument provides a valid measure of time spent in PA, and it is also self-reported. These data were used to create the 4 PA groups. These groups were (1) the no sports participation group, with no time spent in PA per week (except participation in physical education classes); (2) the recreational sports group, with >90 minutes of PA per week (60% of total activity); (3) the school sports group, with >90 minutes of PA per week (60% of total activity); and (4) the federated sports group, with >120 minutes of federated activity (athletes engaged in sports that are regulated by their respective federations, with formal competition). In Portugal, federated sports players are also defined as those who have official recognition for their sport by a sanctioned sports association. These players usually have medical approval to participate and formal training/coaching.

Maturity measures determined maturity offset during adolescence (time before or after peak height velocity [PHV], according to Mirwald et al[31]) and in calculating the bone age from radiographs of left hand and wrist. A random sample of 37 (5.7%) radiographs were assessed independently. The average difference between the independent evaluations of bone age, made 2 weeks after the initial assessments, was 0.02 ± 0.13 years, and the intraobserver error for the replicated measurements was 0.03 ± 0.04 years. In addition to bone age, the subjects were divided into 3 bone maturity categories: late maturing, when the bone age was inferior to the decimal age over 1 year; normal maturing, when the difference between the bone and decimal age was 1 year at most; and early maturing, when the bone age was superior to the decimal age over 1 year.[23,24]

Maturity offset (time before or after PHV) was predicted from a specific equation for each sex (standard estimate error [SEE], 0.592; 0.592 for boys and 0.569 for girls), based on Canadian and Belgian samples.[31] Maturity offset minus chronological age provides an estimate of the age of PHV. Maturity offset can be used to classify adolescents as pre- or post-PHV and group the subjects for years before or after PHV. Applicability of the method appears to be useful during the period of growth acceleration, between 12 and 15 years.[25] This study was limited to boys and girls between 10 and 17 years. The chronological age group was defined with the whole year as the midpoint of the range (ie, 12 = 11.50-12.49). Injury rates were defined as the number of sports injuries per 1000 hours of exposure (training and competition), as also reported by several studies.[5,18,26,40,41]

The data were processed using the SPSS program (IBM Corp). Binary logistic regression and gamma regression were used to identify some significant predictors of injury and injury rate, respectively. The probability value $P \leq 0.05$ was considered to be significant for all analyses. For each sex, the binary logistic regression model was adjusted for the dependent variable injury (1 = yes, 0 = no), considering age group (0 = 10-11 years, 1 = 12-13 years, 2 = 14-15 years, 3 = ≥16 years), maturation level (0 = late, 1 = on time, 2 = early), type of PA (0 = no sports participation, 1 = recreational sports, 2 = school sports, 3 = federated sports), bone age (in years), and maturity offset (in years) as candidate predictors. The backward stepwise method using the Wald statistic was applied for the model variable selection procedure. Linear logistic regression used the same candidate predictors. The significant predictors of injury rate for each sex, log-normal, and gamma regression models were considered because of the positively skewed distribution of injury rates. The backward stepwise method using the Wald statistic was applied for the model variable selection procedure for each sex and each model. For each sex, the log-normal and gamma models were compared using the pseudo R^2, and the attained values let us choose gamma models for both boys and girls. The gamma model was expressed by:

$$Y_i = \exp\left(\beta_0 + \beta_1 x_{i1} + \cdots + \beta_k x_{ik}\right) \times \varepsilon_i$$

where Y_i is the injury rate for subject i, β_0 is the intercept, $\beta_1, \ldots, \beta_k$ are the coefficients associated with the predictors $x_1, \ldots, x_k$, respectively, and ε_i is the random error.

RESULTS

The sample included 647 subjects aged between 10 and 17 years (mean, 13.7 years: SD, 1.8 years); there were 340 boys (52.6%) and 307 girls (47.4%). A total of 247 subjects reported a sports injury during the previous 6 months (37.9%; 95% CI, 34.2-41.7). Considering the analysis by sex, 143 of 340 boys (42.1%) reported an injury and 104 of 307 girls (33.9%) reported an injury. Table 1 summarizes the injury rate data.

Boys: Predictors of Injury

Age group and PA level were selected for the final model as significant predictors for injury (Table 2). Boys who had recreational, school, and federated sports activities were, respectively, 1.325, 8.707, and 4.659 times more likely to have an injury than boys who were less active and only participated in physical education classes. However, the results for the school sports group should be interpreted with caution because there were only 9 boys classified in this PA category (as evidenced by the low precision of the 95% CI for the odds ratio). Considering the age group, the odds ratio for ages 12 to 13, 14 to 15, and ≥16 years when compared with 10 to 11 years was 2.467, 2.149, and 3.296, respectively.

Girls: Predictors of Injury

Only the PA level and maturity offset were included in the final model, as they were significant (Table 2). Girls who had recreational, school, and federated sports activities were, respectively, 1.742, 3.435, and 3.743 times more likely to have an injury than girls who were less active. Relative to maturity offset, girls who had a maturity offset value ≥2.5 were 2.123 times more likely to have an injury than girls who had a maturity offset value <2.5.

Boys: Predictors of Injury Rate

As injury rate was a concern, only the PA level was included in the final model. Injury rate was higher in the no sports participation group than in recreational ($P < 0.001$), school ($P = 0.046$), and federated ($P < 0.001$) groups (Table 3).

Girls: Predictors of Injury Rate

The final model included the PA level, maturation level, bone age, and maturity offset (Table 3). The injury rate was higher in the no sports participation group than in recreational ($P < 0.001$), school ($P < 0.001$), and federated ($P < 0.001$) groups; in the early maturation group ($P = 0.007$) than the late maturation group; and in girls with higher bone age ($P = 0.012$) and lower maturity offset ($P = 0.033$).

DISCUSSION

The increase in sports participation by children and adolescents has created a new population of patients with sports-related injuries,[7] but the current knowledge about PA-related injuries and maturation influence in young children remains limited.[41] Injuries in Portuguese youth were related to PA level, age, and also to biological maturation.

Physical Activity Level

As already addressed in the authors' previous study,[8] school and federated sports presented higher prevalence of injury (OR = 4.21 and 4.44, respectively). The same pattern was reflected when the sample was divided by sex in the present investigation. The odds ratios in boys for recreational, school, and federated sports subjects, when compared with the no sports participation group, were 1.325, 8.707, and 4.659, respectively, and for girls they were 1.742, 3.435, and 3.743, respectively. Data point to the fact that higher injury occurrence is normally related to sports category. Previous research

Table 1. Injury rate by sex, age group, and physical activity level

Injury Rate	Mean	SD	Minimum	Maximum
Total	11.8	8.1	2.3	44.8
Sex				
Female	13.6	9.2	2.8	44.8
Male	10.4	6.9	2.3	44.8
Age group, y				
9.5-11.49	14.4	6.8	3.1	29.6
11.5-13.49	10.9	8.1	2.3	44.8
13.5-15.49	11.4	8.3	2.3	44.8
>15.5	12.1	8.4	2.8	44.8
Physical activity level				
No sports participation	21.9	10.3	14.9	44.8
Recreational	10.8	5.5	3.8	28.3
School	12.6	4.7	6.9	21.7
Federated	8.1	4.7	2.3	34.5

comparing the injury occurrence between elite sports athletes and community-based sports participants found that this is relatively low for community-based sports participants and higher for the federated athletes.[14] Injury prevalence is also substantially lower in sedentary subjects who only participate in physical education classes.[43] Highly specialized athletes had 2.25 greater odds of having sustained a serious overuse injury than unspecialized young athletes.[32] School-age subjects who participate in more competitive levels or who have greater volumes of training have an increased incidence of injury.[20,32] Specifically, exceeding 16 hours per week of total sports participation, regardless of the number of sports, seems to carry the greatest risk.[32,33] These subjects are normally active subjects who play multiple sports, often at a high-intensity level.[42] However, recent studies also are reporting that the risk is even higher when specialized training limits the amount of recreational and unstructured exercise. Young athletes may be able to participate in similar amounts of PA without additional injury risk, meaning the distribution of PA is important.[33] Unlike structured sports practice, unstructured free play is child-directed rather than adult-directed, thus probably explaining its lower injury risk. During free play, when a child gets cold, tired, hungry, bored, or sore, she or he will typically stop; but when the child is being supervised by an adult or is participating in an organized competition, the child may feel expected to continue and therefore be more likely to push through pain or soreness. Structured sports training and competition do not always allow adequate rest periods for a developing child.[20] An accurate assessment of each child's individual sports readiness should be performed to decide whether a child is prepared to enroll in a certain activity and at which level of competition the child can successfully participate.[29] Despite the problems that arise with active children and adolescents, inactive and less active groups can be at risk on those occasions when they do practice sports.[22,38] This situation was revealed when injury rates were analyzed. Conflicting results presented for the variable occurrence of injury. Injury rate was higher in the no sports participation group than in recreational ($P < 0.001$), school (boys, $P = 0.046$; girls, $P < 0.001$), and federated ($P < 0.001$) groups for both sexes. This pattern was already seen in elite athletes, with lower injury rates than the general sporting populations.[22,38]

Poor physical conditioning is considered by the American Physical Therapy Association as the primary cause of sports injury, and there is evidence that physical fitness and experience may play a role in reducing the risk of injury.[4] Children with low levels of habitual PA and those who have not developed at least some level of strength, endurance, and motor skills may be at increased injury risk during leisure-time PA, physical education classes, and sports.[10,33] The lack of diversified activity may not allow the development of the appropriate neuromuscular skills that are effective in preventing an injury. The positive transfer of

Table 2. Logistic regression models adjusted for the dependent variable injury (1 = yes, 0 = no) for boys and girls

Predictor	β (SE)	Wald	*df*	*P* Value	Odds Ratio	95% CI Odds Ratio
	Boys[a]					
Intercept	−2.057 (0.428)	23.098	1	<0.001	0.128	
Age group		7.830	3	0.050		
Age group (1)	0.903 (0.397)	5.164	1	0.023	2.467	(1.132, 5.376)
Age group (2)	0.765 (0.395)	3.745	1	0.053	2.149	(0.990, 4.664)
Age group (3)	1. 3 (0.436)	7.466	1	0.006	3.296	(1.401, 7.753)
Physical activity		35.596	3	<0.001		
Physical activity (1)	0.281 (0.375)	0.563	1	0.453	1.325	(0.635, 2.764)
Physical activity (2)	2.164 (0.785)	7.595	1	0.006	8.707	(1.868, 40.580)
Physical activity (3)	1.539 (0.325)	22.392	1	<0.001	4.659	(2.463, 8.813)
	Girls[b]					
Intercept	−1.408 (0.220)	40.830	1	<0.001	0.245	
Physical activity		18.057	3	<0.001		
Physical activity (1)	0.555 (0.309)	3.226	1	0.072	1.742	(0.951, 3.194)
Physical activity (2)	1.234 (0.404)	9.325	1	0.002	3.435	(1.556, 7.584)
Physical activity (3)	1.320 (0.355)	13.853	1	<0.001	3.743	(1.868, 7.499)
Maturity offset ≥2.5	0.753 (0.289)	6.764	1	0.009	2.123	(1.204, 3.743)

SE, standard error.
[a]Overall model evaluation (likelihood ratio test), $\chi^2(6) = 47.861$, $P < 0.001$; goodness-of-fit test,[19] $\chi^2(7) = 0.267$, $P = 1.0$; Cox and Snell[9] $R^2 = 0.130$; Nagelkerke[34] $R^2 = 0.175$; percent correct classification = 67.9%.
[b]Overall model evaluation (likelihood ratio test), $\chi^2(3) = 20.513$, $P < 0.001$; goodness-of-fit test,[19] $\chi^2(2) = 0.000$, $P = 1.0$; Cox and Snell[9] $R^2 = 0.064$; Nagelkerke[34] $R^2 = 0.089$; percent correct classification = 67.2%.

skills with diversification is important in the successful development of a young child.[32]

Age

It is generally acepted that injury ocurrence increases with age.[41] Portuguese data also showed this pattern. Older adolescents had 2.26 times more risk of having an injury than younger ones.[8] In the United States, young athletes who were injured had 1.67 times the odds of being older than 14 years when compared with uninjured athletes, after adjusting for weekly sports hours. The observed increase in injury incidence coincides not only with an increase in age but also with an increase in exposure.[5] For most sports, as athletes get older and advance to higher levels of competition, training volume naturally increases.[20] It is also known that sports attrition rates are the highest during the transitional years of adolescence[29] because of the growth process and development. Also specialization, pressure to perform, and intensity increase with age.[22,26,27] In young athletes, substantial increments in training occur during pubertal years that correspond to the period of maximal annual gains in stature and body mass. This means that the demands of the sport are superimposed on those of normal growth and maturation. High training load overlapping maximal annual changes in growth increases the risk of sport injuries.[40] The present study found age as a predictor of injury in the male sample. Boys who were aged 12 to 13, 14 to 15, and ≥16 years were, respectively, 2.467, 2.149, and 3.296 times more likely to have an injury than boys who were aged 10 to 11 years. Sports involvement lasts longer in boys than in girls, and their growth process occurs later, which can explain why we found this trend only in the male sample.

Maturation

Growth and maturation are potential risk factors for sports injury.[40] Children of the same chronological age may vary considerably in biological maturity status, and individual

Table 3. Gamma regression models adjusted for the dependent variable injury rate for boys and girls

Predictor	*B* (SE)	Wald	*df*	*P* Value	Wald 95% CI
	Boys[a]				
Intercept	3.022 (0.126)	1441.164	1	<0.001	(2.775, 3.268)
Physical activity		46.263	3	<0.001	
Physical activity (1)	–0.626 (0.161)	15.124	1	<0.001	(–0.941, –0.310)
Physical activity (2)	–0.479 (0.241)	3.964	1	0.046	(–0.951, –0.007)
Physical activity (3)	–0.892 (0.126)	43.171	1	<0.001	(–1.158, –0.626)
	Girls[b]				
Intercept	1.278 (0.794)	2.587	1	0.108	
Physical activity		104.126	3	<0.001	
Physical activity (1)	–0.748 (0.112)	44.816	1	<0.001	(–0.967, –0.529)
Physical activity (2)	–0.606 (0.126)	23.078	1	<0.001	(–0.854, –0.359)
Physical activity (3)	–1.139 (0.115)	98.311	1	<0.001	(–1.364, –0.914)
Maturation level		7.475	2	0.024	
Maturation level (1)	–0.386 (0.206)	3.499	1	0.061	(–0.790, 0.018)
Maturation level (2)	–0.701 (0.262)	7.150	1	0.007	(–1.215, –0.187)
Bone age	0.179 (0.072)	6.281	1	0.012	(0.039, 0.320)
Maturity offset	–0.205 (0.096)	4.525	1	0.033	(–0.393, –0. 160)

SE, standard error.
[a]Overall model evaluation (likelihood ratio chi-square test): $\chi^2(3) = 46.710$, $P < 0.001$; goodness-of-fit test (Pearson chi-square): $\chi^2(139) = 42.980$, $P = 0.309$; pseudo $R^2 = 0.235$.
[b]Overall model evaluation (likelihood ratio chi-square test), $\chi^2(6) = 55.646$, $P < 0.001$; goodness-of-fit test (Pearson chi-square), $\chi^2(96) = 19.261$, $P = 0.201$; pseudo $R^2 = 0.513$.

differences in maturity status influence measures of growth and performance during childhood and adolescence.[22] Studies have confirmed that approximately one-third of all players of 1 age category were not within their normal maturity category. Chronological age is not always a good measure for categorizing children and adolescents in competitive levels, and it is probably not a good development indicator.[11] Athletes more advanced in their biological maturity perform better, are structurally and functionally stronger than their late-maturing peers, and have a better chance of succeeding in their sport.[40] Unbalanced competition between early and late maturing athletes in contact sports contributes to at least some of the serious injuries in these sports.[22] Heavier, faster players generate a larger impact force and the injury risk increases for the opponents and themselves.[36] Cognitive skills, coordination, balance, visual perception, and eye-hand coordination are achieved through physical maturation and playing experience. On the other hand, the susceptibility for a variety of musculoskeletal injuries increases during periods of rapid growth because there is an enhanced environment for injury, making the immature musculoskeletal system less able to cope with trauma situations and repetitive biomechanical stress.[30] Longitudinal growth occurs initially in the long bones, creating asynchronous development of bone and soft tissue.[7] The soft tissues do not follow this rapid bone growth, becoming progressively tighter,[29,30] and although controversial, loss of flexibility may occur.[22,30] Muscle-tendon units become tensioned, increasing the risk of joint-related injury.[7,20,22,29,30] Bone mineralization may also lag behind, thus rendering the bone temporarily more porous and subject to fractures.[22] Moreover, biomechanical and clinical evidence suggest that cartilage and growth plates are less resistant than in the mature adult counterpart.[10,30] Imbalance between strength and flexibility can happen, resulting in structural laxity that is normally present.

These results clearly demonstrate biological maturation as a predictor of injury in girls. Mature girls, early-maturing girls, and girls just beyond PHV showed significant results. Older girls, ahead of their PHV by at least 2.5 years, had the risk of injury increased 2.123 times. As already noted, the effect of age may be partly explanatory; however, mature girls have a number of social and morphological conditions that attach them to other tasks in society, which often means having less productive opportunities for PA practice. Their bodies are less adapted (more fat), which often determines restraints in the sports practice itself and a less appropriate response to stimuli. Similarly, early-maturing girls ($P = 0.007$) with higher bone age ($P = 0.012$) also had higher rates of injury risk. This pattern was found in some studies where injury incidence was higher in early-maturing compared with late-maturing athletes.[13]

In addition, skeletally mature but still muscularly weak subjects were more susceptible to injury compared with peers of the same chronological age. Early-maturing subjects even showed a higher number of tendinopathies and reinjuries.[3] This girls' group still faces another circumstance, which is that the cognitive stage may not follow physical maturation. Young children who are distracted easily may not be capable of participating in highly structured programs. Training programs that do not take into account the child's developmental status may increase the risk for injury associated with the lack of understanding and motivation.[10] Also, girls who have just passed PHV ($P = 0.033$) registered higher injury rates. Increased vulnerability for traumatic and overuse injuries has been reported during and after the PHV period.[40] Higher injury rates are associated with periods of rapid growth based on developmental stages in young elite female gymnasts.[20] These girls are also more frequently and intensively engaged in sports practice, undergoing an unbalanced phase of motor control and tissue changes. Although the characteristics of this study do not allow us to draw these conclusions, these same girls are exposed to direct contact with mature girls of the same age, which causes them to be at a marked disadvantage in terms of size and body proportions. Some studies of female athletes have highlighted how maturation can lead to an increased risk of injury, although there is still a lack of evidence supporting this cause/effect relationship.[5,20] Risk associated with maturational level still needs to be clarified.

CONCLUSION

Levels of activity and maturation can be a determinant predictor of injury. Sports injuries arise at all levels of PA; early-maturing girls, and those girls who have just passed PHV, may be particularly vulnerable. Assessment of each child's biological age and individual sports readiness should be performed to evaluate and determine possible risks and to decide at which level of PA the child can successfully participate. Preventing injuries and ensuring safe athletic practices is crucial to achieve the benefits from PA.

ACKNOWLEDGMENT

The authors would like to express their immeasurable gratitude to Ana Lúcia Silva and João Albuquerque for helping in data collection and Carlos Barrigas for evaluating all radiographs. They also thank to Escola Básica 2,3 Professor Delfim Santos, Agrupamento de escolas de Portela e Moscavide and Escola Secundária Quinta do Marquês, for making both their infrastructures and students available for the study and to all participants for their time and effort. Ana Lúcia Silva and João Albuquerque were supported by a scholarship from the Portuguese Foundation for Science and Technology (SFRH/BD/91029/2012 and PTDC/DES/113156/2009, respectively) and by the Interdisciplinary Center for the Study of Human Performance (CIPER).

Clinical Recommendations

SORT: Strength of Recommendation Taxonomy Grade
A: consistent, good-quality patient-oriented evidence
B: inconsistent or limited-quality patient-oriented evidence
C: consensus, disease-oriented evidence, usual practice, expert opinion, or case series

Clinical Recommendation	SORT Evidence Rating
Because of the variation in timing of maturation, chronological age may not be necessarily an accurate indicator of the level of injury risk. Instead, measures of maturation may offer a more accurate guide and therefore provide guidance when determining desirable training loads during certain growth and maturation phases.	B
PA practice contexts should respect physical and psychological immaturity/maturity of the growing athlete.	C

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