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Original Article

Quantification of physical activity of Malaysian traditional games for school-based intervention among primary school children

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الملخص

أهداف البحث: يمكن زيادة النشاط البدني للأطفال من خلال دمج الأنشطة القائمة على الألعاب مثل الألعاب التقليدية خلال جلسات التربية البدنية. ولكن، مستوى النشاط البدني لهذه الألعاب لم يتم تحديد كميته. وتهدف هذه الدراسة إلى تحديد كمية مستوى القوة للألعاب الماليزية التقليدية الشائعة (بمعنى آخر، غالاه بانجانج، بولا بيراكون، بوليس سينتري، بلالانج بيلاتوك، ايام مسانغ وبالات تن) بين أطفال المدارس الابتدائية الذين أعمارهم ٩-١١ عاما (العدد=٣٠).

طرق البحث: استخدمنا مقياس التسارع لقياس عدد الخطوات، ومهمة التمثيل الغذائي المكافئ، ومستوى القوة، وحجم النواقل خلال ٢٠ دقيقة من جلسات اللعب. كما تم توحيد مساحة اللعب لكل لعبة إلى حجم ملعب تنس الريشة (بمعنى آخر ١٣.٤ مترا في الطول و٦.١ في العرض).

النتائج: أظهرت النتائج أن الألعاب التقليدية الماليزية الثلاثة، المسماة غالاه بانجانج، وبولا بيراكون، وبالات تن، استوفت متطلبات التصنيف كقوة النشاط البدني المعتدل إلى القوي من حيث عدد الخطوات، ومهمة التمثيل الغذائي المكافئ، ومعدل ضربات القلب والحركة في جميع المستويات.

الاستنتاجات: أظهرت هذه الدراسة أن ممارسة الألعاب التقليدية لمدة ٢٠ دقيقة ممكن أن تزيد النشاط البدني بين طلاب المدارس الابتدائية.

الكلمات المفتاحية: مقياس التسارع؛ الميكانيكا الحيوية؛ معدل ضربات القلب؛ قوة النشاط البدني المعتدل إلى القوي؛ التعليم البدني

Abstract

Objective: Children's physical activity can be increased by integrating game-based activities, such as traditional games, into physical education sessions. However, the level of physical activity of these games has not been quantified. This study aims to quantify the level of intensity for common Malaysian traditional games (i.e. *Galah Panjang, Bola Beracun, Polis Sentri, Belalang Belatuk, Ayam Musang,* and *Baling Tin*) among primary school children aged nine to 11 years (N = 30).

Methods: We used an accelerometer to measure step count, metabolic equivalent task, level of intensity and vector magnitude during 20 min playing sessions. The playing space was standardised for each game to the size of a badminton court (i.e. 13.4 m in length and 6.1 m in width).

Results: The results showed that three traditional Malaysian games, namely *Galah Panjang, Bola Beracun* and *Baling Tin,* fulfilled the requirements to be classified as moderate-to vigorous-intensity physical activity in terms of step count, metabolic equivalent task, heart rate and motions in all planes.

Conclusion: This study shows that playing traditional games for 20 min can increase physical activity among primary school students.

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Keywords: Accelerometer; Biomechanics; Heart rate; MVPA; Physical education

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Introduction

Traditional games are essential in promoting cultural diversity and in protecting cultural identity at the local, national and international levels.[1] Certain traditional games representing specific countries have been recognised by UNICEF, UK Sport and the British Council as the International Inspiration programme, including circle *Sepak Takraw* for Malaysia.[2] Following UNESCO's recommendation, the Malaysian Ministry of Education (MOE) has included traditional games in the physical education (PE) syllabus since 2013, mainly in primary school grades one, two and four (children aged seven, eight and ten years, respectively). Traditional games require skills that are important for the development of fundamental motor skills—locomotor and object control skills.[3] Playing traditional games also enhances children's motor abilities, speech development, knowledge acquisition process, curiosity, muscle mass, senses, posture and balance.[4] Besides, children learn about themselves (i.e. self-awareness), others and the environment through traditional games.[4] These have also been implemented in school syllabi, such as in Macedonia and Iran, positively increasing physical activity and enhancing abilities in mathematics, science, geography and spelling among children.[4] However, in both studies,[4,5] data were collected through interviews and questionnaires without any objective assessment of the traditional games' level of intensity.

Few studies have utilised traditional games as a school-based intervention. Akbari et al. (2009)[3] studied the effects of traditional Iranian games on the fundamental motor skills of primary school boys aged seven to nine years. They observed that eight weeks of traditional games intervention were more effective than daily activities (i.e. the control group) in improving the locomotor and object control skills among children.[3] Meanwhile, Charles et al. (2017)[6] have investigated the effects of Malaysian traditional games (i.e. *Ketinting, Galah Panjang, Tor Duduk* and *Tok Harimau*) on motor fitness in 40 children (i.e. 20 boys and 20 girls) with a mean age of 12 years. The intervention spanned eight weeks, with three sessions per week of different duration—15 min per session for the first four weeks and 10 min per session for the remaining four. They found that motor fitness was significantly improved at the post-test compared to the baseline level; however, the level of intensity of the traditional games in Akbari et al.[3] and Charles et al.[6] was not evaluated. Therefore, the mechanism of how playing traditional games may affect children's health and development has not yet been understood.

Physical inactivity among Malaysian children has become endemic.[7] The majority of Malaysian children and adolescents are involved in low levels of physical activity, whereby only 22.8% of Malaysian students are physically active for at least 60 min per day for five or more days per week.[7] Globally, only 42% of children aged six to 11 years are involved in moderate-to vigorous-intensity physical activity (MVPA) for 10−16 min per day.[8] It was shown that PE is essential in enhancing the daily involvement of children in MVPA, particularly of those who are unfit and inactive.[9] It is important to note that participation in MVPA directly influences motor skills ability among children[10]; it is thus crucial to encourage participation in MVPA in the age groups prior to puberty[11] because children must have mastered fundamental motor skills when their process of growth ends.[12] Failure to develop fundamental motor skills during pre and primary school years may lead to failure in developing motor competence during adulthood, which will further reduce participation in sports and physical activities.[12] As Malaysians typically reach puberty just before turning 12,[13] our study population comprised prepubertal children.

Since traditional games are played during PE sessions in Malaysian primary schools, it is essential to evaluate their level of intensity. To the best of our knowledge, no studies have been conducted that quantify the intensity of traditional games across the world, despite UNESCO calling for these games to be studied and profiled scientifically. Hence, the purpose of the current study was to quantify the level of intensity based on step count, heart rate, vector magnitude of motions and metabolic equivalent task (MET) for selected Malaysian traditional games. By identifying the level of intensity of these games, school authorities may improvise PE sessions among primary school children to achieve the minimum level of daily MVPA.

Materials and Methods

The study was a cross-sectional study. The population was sampled using purposive sampling from a list of primary schools located in the urban area of Kota Bharu, Kelantan, Malaysia. With permission from their school headmaster, 30 students aged nine to 11 years were included in the study. The participants and their guardians were informed about the details of the study, including the objectives, procedures and possible risks.

Participants

The participants were randomly selected. Out of five classes for each age group, one class was randomly selected by the school's principal. Then, five boys and five girls from the selected classes were randomly chosen by the related homeroom teacher to participate in the study. If anyone refused to participate, the invitation was extended to other volunteers in the same class. Only boys and girls aged 9−11 years (i.e. five boys and five girls of each age group) without any health problems were included in the study. Meanwhile, children with illnesses or physical disabilities such as

cardiovascular diseases or muscular dystrophy, which might prevent them from completing the study, were excluded.

Calculation of sample size

The sample size for the study was calculated using G*Power software (3.1.9.2). Type 1 error for a two-tailed test was set at 0.05, while the power of the study was set at 0.95 with critical t = 2.07 and degree of freedom df = 22. An effect size of 0.2 was set based on the significant changes in motor skills following traditional games school-based intervention among primary school children[3]; hence, the calculated sample size was 23. A 30% drop-out rate was considered, following which a total of 30 participants were recruited.

Study procedure

We followed the protocol by Centre for Disease Control and Prevention[14] to determine paediatrics' anthropometric using the age percentiles chart. The participants' body weight and height were measured to the nearest 0.1 kg using a Digital Scale (Seca, Hamburg, Germany) and the nearest 0.1 cm using a stadiometer (Seca 220, Hamburg, Germany), respectively. The body mass index (BMI) was calculated from the body weight and height data (kg/m^2), and hip and waist circumferences were measured to the nearest 0.1 cm using a non-stretchable measuring tape. All measurements were taken while the children were barefoot and wore light clothes, and were recorded by the principal researcher.[9]

The amount of steps and the MET indicate an activity's level of intensity[15]; it was therefore evaluated in each traditional game using the accelerometer GT3X+ (ActiGraph Pensacola, Florida, USA). The accelerometers were calibrated and initialised before being attached to the participants. During the initialisation process, parameters such as age, weight, height and BMI were included. The sampling rate was set at 30Hz, and the epoch length was set at every 60 s. Next, the accelerometer was attached to the right side of each participant's waist to record their movement during the sessions. The flashing LED light indicated that data were being collected; then, the recorded data were downloaded into ActiLife V.6 software (ActiGraph Pensacola, Florida, USA) for analysis. Heart rate was recorded using Polar heart-rate monitor (Polar, USA). The electrode area of the strap was drained under running water to ensure it was well moistened. Then, the strap was tied around the chest, and the hook was firmly attached to the skin, ensuring that the upright position of the Polar logo on the connector was at the centre of the chest.[16] Heart rate data were recorded before and immediately after the test. For the post-activity heart rate, data were recorded within 5 min after the activity ended.[17]

Traditional games

All the participants played six Malaysian traditional games, namely *Ayam Musang, Bola Beracun, Baling Tin, Galah Panjang, Polis Sentri* and *Belalang Belatuk*, with each game being played on separate days (i.e. one game during each PE session). Each traditional game was played for 20 min as suggested by Biddle and Armstrong (1992)[18] for games activity among primary school children. Eight to 10 min of warm-up and cool-down sessions were conducted prior to and following the game session. The playing space, which was the size of a badminton court (i.e. 13.4 m in length and 6.1 m in width) was fixed for each game. The standardisation of the playing area, which had not been applied in previous studies on traditional games as a school-based intervention, was improvised in the current research. The description of each traditional game was based on the recent Malaysian PE syllabus, which was briefly explained as the following:

Galah Panjang

The players were divided into two groups (i.e. running and tagging teams) with an equal number of teammates. The objective of the running team was to get to the other end of the court by avoiding and cleverly manoeuvring past the tagging team. Each time a player from the running team ran to the starting point again, the team scored a point. However, if the player was caught, the point was awarded to the tagging team. The game continued until one team obtained the highest scores in the 20 min of play. *Galah Panjang* requires speed, coordination and agility to win.

Belalang Belatuk

The game started by dividing the participants into two groups, *belalang* and *belatuk*, and two places (i.e. home), namely the *belalang* and *belatuk*'s homes. When the researcher shouted '*Belatuk!*', the *belalang* group had to catch the *belatuk* group members and prevent them from returning to their home. If the opponent caught the *belatuk* member, they would be transferred to the opponent group. The game continued with the researcher continuously calling '*Belalang*' or '*Belatuk*' in random sequences, and the winning group was the one with most members at the end of the 20-min session. This game requires quick reaction time, agility and speed. Furthermore, as the teams' home area is situated on the side, the players should be able to run sideways to get to their homes faster.

Polis Sentri

In this game, participants were divided into two groups (i.e. police and thief groups). The police group had to catch the thief group and put them in a designated jail, while the thief group had to release their jailed members. The game ended when all members of the thief group were captured and jailed. The winner was the group with the least number of jailed members at the end of the 20-min session. This game requires high endurance, speed and agility.

Bola Beracun

This is a rally game similar to dodgeball, but it can be played in a smaller space with only a single ball. The objective of the game was to avoid the ball that was thrown around for 20 min, and only throws hitting the players below the waist were considered valid. Those who were hit by the ball had to leave the playing area. The teams took turns to be either the ones throwing or those being thrown at. The winner was the group with the highest number of members after the session ended. This game challenges object manipulation (i.e. throwing and catching ball), running and jumping skills.

Baling Tin

Otherwise known as throw-the-cans, the game is also called as *Tuju Tin* or *Baling Tin* in the Malay language. Players were divided into two groups (i.e. teams A and B), whereby each team had two chances to throw a ball against the cans. If none were able to knock down the cans, they would lose their turn. The game started when they knocked down the cans that Team A players scattered within the predetermined space to avoid getting hit by a ball and being kicked out of the game by Team B players. Team A players had to restack all cans again while preventing them from getting hit by the ball. On the other hand, Team B players had to chase Team A players and stop them from stacking the cans. If Team A players managed to gather the cans before all their players were deemed 'out', they would win the game. This game requires the skill to manipulate objects (i.e. throwing and catching ball), fast running, quick thinking and agility.

Ayam Musang

In this character-based game, one player volunteered to be the 'hen', one the 'fox', and the rest the 'chickens'. The hen and chickens lined up and held hands and waist, with the hen at the front of the line. The fox had to look for opportunities to catch the chickens, while the hen's duty was to defend the chickens from being caught. *Ayam Musang* requires speed, coordination, strength and agility to win.

Measurement of the level of intensity of selected traditional games

The objective of the study was to quantify the level of intensity for each traditional game. Step count data were recorded using the accelerometer GT3X+ (ActiGraph Pensacola, Florida, USA) during the play session. These data are the composite of vector magnitude of motions in three planes, namely vertical, horizontal and perpendicular. The reliability of measuring step count using an accelerometer is 0.99.[19] The level of intensity for traditional games was evaluated based on the cut-off points for step count, as recommended by Freedson et al. (2005);[15] these were chosen based on the participants' age, the motions involved and the type of acceleration device.[15]

MET was calculated from the step count data based on the equation provided by Freedson et al. (2005).[15]

MET = 2.757 + (0.0015 X count per minute) − (0.08957 X age (in years)) − (0.000038 X count per minute X age (in years))

Heart rate was recorded using a Polar heart-rate monitor (Polar, USA) during the traditional games sessions.

Statistical analysis

One-way ANOVA was applied to compare the step count, heart rate, MET, level of intensity and vector magnitude in vertical, horizontal and perpendicular axes across six traditional games during the 20-min playing session. Post-hoc Tukey's test was used for multiple comparisons if any significant difference was detected. Descriptive analyses were also conducted to determine the physical characteristics of the participants. All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 22.0. The level of significance was set at $p < 0.05$.

Results

Thirty participants were recruited for the study. The descriptive data of the participants' physical characteristics are presented in Table 1, while the descriptive data of step count, heart rate and MET for each traditional game are shown in Table 2.

The distribution of anthropometric variables was verified using the Shapiro−Wilk test. The data were normally distributed for height ($p = 0.149$) and hip circumference ($p = 0.277$); however, bodyweight ($p = 0.015$), BMI ($p = 0.000$), and waist circumference ($p = 0.011$) were not normally distributed. The data were positively skewed, which was due to the normal growth of children aged 9−11 years.

The data for the level of intensity of selected traditional games were normally distributed only for *Galah Panjang* ($p = 0.206$) but not for *Polis Sentri* ($p = 0.001$), *Baling Tin* ($p = 0.038$), *Belalang Belatuk* ($p = 0.009$), *Ayam Musang* ($p = 0.001$) and *Bola Beracun* ($p = 0.047$).

The test of homogeneity of variances showed significance only for step count (8.635, $p = 0.000$) and MET (2.443, $p = 0.036$), and one-way ANOVA revealed statistically significant differences in step count ($F = 291.01$, $p = 0.000$) for all traditional games (Table 3). Meanwhile, the post-hoc

Table 1: Physical characteristics of participants (N = 30).

Variables	Mean ± SD
Age (years)	10.00 ± 0.85
Height (cm)	134.51 ± 6.42
Weight (kg)	30.40 ± 6.80
BMI (kg/m^2)	16.80 ± 3.51
Waist circumference (cm)	58.85 ± 2.74
Hip circumference (cm)	67.91 ± 2.74

Data are presented as mean ± standard deviation.
cm = centimeter, kg = kilograms, kg/m^2 = kilograms per meters squared.

Table 2: The descriptive results for step count, heart rate, metabolic equivalent task (MET) for each traditional game.

Traditional Game	Step Count (cpm)	Heart Rate (bpm)	MET
Galah Panjang	1170.53 ± 158.39	108.06 ± 29.55	3.41 ± 1.04
Baling Tin	1096.53 ± 152.48	114.20 ± 13.57	3.17 ± 0.83
Polis Sentri	1091.07 ± 180.94	98.67 ± 12.18	3.61 ± 0.65
Bola Beracun	1057.67 ± 104.74	112.33 ± 12.81	3.72 ± 0.78
Belalang Belatuk	961.67 ± 76.92	99.93 ± 17.81	2.97 ± 0.73
Ayam Musang	880.93 ± 88.45	97.67 ± 9.45	2.64 ± 0.62

Data are presented as mean ± standard deviation, cpm = count per minute, bpm = beats per minute.

Table 3: Comparison of heart rate across selected traditional games (N = 30).

Variables	Sum of squares	Mean square	F	p-value
Step count				
Between-group	22535285.16	4507057.03	291.01	0.000
Within-group	2694832.23	15487.54		
Heart rate				
Between-group	7517.43	1503.48	5.677	0.000
Within-group	46078.23	264.81		
MET				
Between-group	25.22	5.04	8.02	0.000
Within-group	109.38	0.62		

Significance at $p < 0.05$*.

Tukey's test showed that the step count for *Galah Panjang* was significantly greater ($p = 0.001$) than that of other games except for *Baling Tin*. On the other hand, the step counts for *Bola Beracun, Belalang Belatuk* and *Ayam Musang* were significantly lower ($p = 0.001$) than *Galah Panjang, Baling Tin* and *Polis Sentri*.

Furthermore, one-way ANOVA indicated statistically significant differences in heart rate ($F = 5.677$, $p = 0.000$) for all traditional games. The post-hoc Tukey's test also showed statistically significant differences in heart rate between *Baling Tin* and *Belalang Belatuk* ($p = 0.018$), between *Baling Tin* and *Ayam Musang* ($p = 0.001$), between *Galah Panjang* and *Ayam Musang* ($p = 0.011$), and between *Ayam Musang* and *Bola Beracun* ($p = 0.004$).

Moreover, one-way ANOVA showed statistically significant differences for the average MET ($F = 8.02$, $p = 0.000$) across all traditional games. The post-hoc Tukey's test revealed statistically significant differences in MET between *Polis Sentri* and *Belalang Belatuk* ($p = 0.025$), between *Polis Sentri* and *Ayam Musang* ($p = 0.000$), between *Galah*

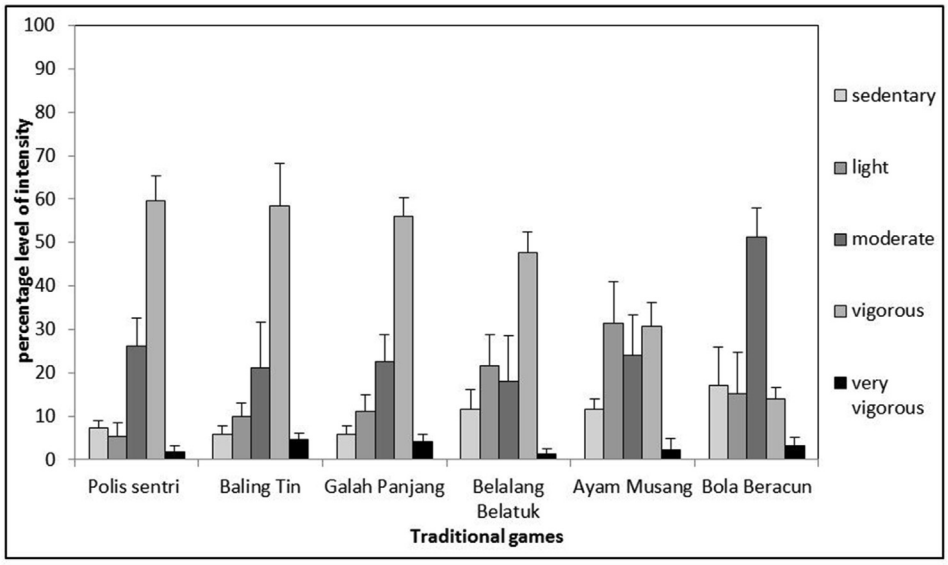

Figure 1: The percentage of the level of intensity among selected traditional games.

Table 4: The descriptive results for vector magnitude for each traditional games (N = 30).

Traditional Game	Vector magnitude (cpm)		
	Vertical	Horizontal	Perpendicular
Polis Sentri	2351.12 + 468.46	2375.37 + 367.82	3214.86 + 490.50
Baling Tin	2464.50 + 630.71	2387.58 + 510.40	3271.98 + 781.50
Galah Panjang	2464.50 + 630.71	2387.58 + 510.40	3271.98 + 781.50
Belalang Belatuk	2300.66 + 441.00	2861.84 + 757.43	3196.98 + 695.32
Ayam Musang	2174.35 + 442.23	2318.66 + 541.20	3103.75 + 465.96
Bola Beracun	2673.32 + 749.08	2578.49 + 509.20	3405.01 + 801.48

Data are presented as mean ± SD, cpm = count per minute.

Panjang and *Ayam Musang* ($p = 0.003$), between *Belalang Belatuk* and *Bola Beracun* ($p = 0.004$), and between *Ayam Musang* and *Bola Beracun* ($p = 0.000$).

The percentage of the level of intensity and directions of motion were evaluated from the step count data, which were quantified using the accelerometer GT3X+. Figure 1 illustrates the percentage of the level of intensity for each traditional game. Statistically significant differences in the percentage of the level of intensity ($F = 291.01$, $p = 0.000$) were observed across all traditional games.

Meanwhile, vector magnitude data were analysed and quantified using the directions of motion in the vertical, horizontal and perpendicular axes for each traditional game. The descriptive results are presented in Table 4. The traditional game with the highest value in the vertical and perpendicular direction of motion was *Bola Beracun*, while *Belalang Belatuk* showed the highest value in the horizontal direction of motion. One-way ANOVA reported no statistically significant different values for the perpendicular axis (0.666, $p > 0.05$) in each traditional game. Statistically significant differences in vertical ($p = 0.023$) and horizontal ($p = 0.001$) axes were observed for *Bola Beracun* and *Belalang Belatuk* only.

Discussion

Children aged five to 18 years should engage in MVPA for at least 60 min per day and three days per week.[20–23] This daily requirement can be a combination of PE class, free play and recreational activities or planned exercise.[24] Additionally, children and youths should also participate in vigorous-intensity physical activity (PA) for at least three days per week[25]; hence, the purpose of the current study was to determine the level of intensity of common Malaysian traditional games in order to enhance PA among Malaysian children.

The intensity level of PA can be determined through self-report, questionnaires, accelerometers, pedometers or the workload of a training programme.[26] Directly assessing children's PA through an accelerometer is a recommended, valid and reliable method.[23] The accelerometer is viewed as the gold standard in measuring movement patterns among children, although it may not be as accurate as energy expenditure evaluation via an oxygen consumption device[23]; moreover, it is accurate in monitoring the patterns of PA in terms of frequency, intensity and duration of activity.[23] On the other hand, self-report or questionnaires among young children (i.e. younger than 10 years) are not accurate and lack the validity to measure the intensity level of children's PA.[23] Previous studies utilised accelerometers to determine the step count, MET and vector magnitude in PA among children.[27–29] Recorded activity by the accelerometer is read as an epoch, whereby most studies that involve children set the epoch at 60 s.[28] The accelerometer can convert acceleration signals to counts, and the sum of these counts over an epoch (i.e. time interval) can determine the MET. Step count or count per minute (cpm) in accelerometers is widely used to measure the level of intensity of PA based on the cut-off points, which are developed based on the activity and age-specific criteria. Many are the models of cut-off points that can be used to determine the level of intensity of PA, such as those suggested by Freedson et al.,[15] Guinhouya et al.,[22] Freedson et al.,[30] Trost et al.,[31] Puyau et al.,[32] Treuth et al.,[33] Mattocks et al.[34] and Evenson et al.[35]

The determination of the level of intensity of PA is commonly based on age. For instance, Evenson's model[35] is mostly used in the determination of the level of intensity of PA among pre-schoolers. For children aged six to 17 years, Freedson's cut-off points[15] is deemed the most common, followed by Puyau's[32] and Treuth's[33] cut-off points models. Freedson's level of MVPA[15] is 500−7599 cpm, which is contrary to Guinhouya et al.'s[22] definition of MVPA that is between 1000 and 4000 cpm. The selection of the cut-off point for step count should be specific for the studied population as the participants' leg length may determine the magnitude of it.

Additionally, the cut-off point for the PA level of intensity is also based on the specific activity being measured. For example, Puyau's model[32] is based on slow walking, Trost's model[31] is based on slow running, while Freedson's model[15] is based on fast running. Therefore, as the studied activity involved fast running, the current study followed Freedson's model[15]. Moreover, Freedson et al.[11] have stated that the sample size must consist of at least 10 children per group.

Step count is one of the fundamental units in human locomotion and is a preferred method to quantify PA.[36] The number of steps is correlated to one's level of physical work capacity.[36] Our results showed that the step count data were significantly different across the traditional games, namely *Galah Panjang, Belalang Belatuk, Polis Sentri, Bola Beracun, Baling Tin* and *Ayam Musang*. The average step count for all traditional games is approximately between 880 and 1170 cpm (Table 2), which indicates that these games fulfil the requirement of moderate-intensity activity

based on the cut-off points by Freedson et al.[15] Therefore, playing these traditional games during PE lessons is sufficient to meet the MVPA requirement.

The movement pattern and the games' rules may cause *Galah Panjang, Baling Tin* and *Polis Sentri* to achieve the highest value of step counts compared to other traditional games. Additionally, these games involve fast running and active participations from all team members. On the contrary, *Ayam Musang* has the lowest value of step count. This is probably because the rules of this game may not encourage all players to participate all the time, whereby only a few players at the end of the chicken line and the fox will move actively compared to those who are closer to the hen. Our findings showed that each game's playing pattern and rules might influence the amount of step count. Hence, to achieve children's recommended daily MVPA, PE teachers may incorporate traditional games that encourage all children to move, such as *Galah Panjang* and *Belalang Belatuk*.

Heart rate, which can be evaluated accurately using a heart-rate monitor, is another method to determine PA's level of intensity. Heart rate is a non-invasive index rate of cardiac autonomic activity, which is valuable for assessing health.[37] Usually, the PA's intensity level is not directly measured through heart rate; heart rate responses indicate the volume of PA,[38] whereby increasing heart rate is parallel with increasing the intensity of activity.[39] For instance, children were reported to be in a steady-state heart rate during moderate-intensity activities. However, their heart rate increased sharply when the intensity increased, or during vigorous PA.[39] The level of intensity can be identified from heart rate data during the 20 min of PA.[32] *Polis Sentri, Belalang Belatuk* and *Ayam Musang* reported a mean heart rate value of less than 100 bpm, whereas *Baling Tin, Galah Panjang* and *Bola Beracun* recorded a mean heart rate of approximately 108–114 bpm (Table 2). This could be related to the step count, whereby *Galah Panjang* and *Baling Tin* were two games that recorded the greatest step count compared to the other games.

The results show statistically significant differences in MET for each traditional game in Table 3. Traditional games such as *Belalang Belatuk* and *Ayam Musang* only reached approximately 2MET, while *Polis Sentri, Baling Tin, Galah Panjang* and *Bola Beracun* were able to achieve 3MET. For PA involving children aged 6–17 years, 4MET is the minimum of MVPA.[8] In terms of MET, none of the traditional games studied achieved the minimum requirement.

Statistically significant differences were observed in the percentage of the level of intensity for each selected traditional game. The percentage level of intensity referred to the time spent at a specific level of intensity of PA, namely sedentary, light, moderate, vigorous and very vigorous. The higher the percentage the more time is spent at a specific level of intensity. *Galah Panjang* shows the highest percentage in very vigorous-intensity, followed by *Baling Tin* and *Bola Beracun* (Figure 1). *Polis Sentri,* followed by *Galah Panjang* and *Baling Tin,* were the top three games with the highest percentage of vigorous-intensity.

Meanwhile, *Bola Beracun, Ayam Musang* and *Polis Sentri* are the top three games with the highest percentage of moderate-intensity. Therefore, for the moderate-intensity level, the percentage is in decreasing sequence as follows: *Bola Beracun* (51.66%), *Ayam Musang* (27.13%), *Polis Sentri* (24.96%), *Baling Tin* (22.53%), *Galah Panjang* (21.50%) and *Belalang Belatuk* (19.96%). Each traditional game showed different patterns of the percentage level of intensity. Overall results showed that *Bola Beracun* was the only traditional game that reached at least 50% of its duration as a moderate-intensity activity. Meanwhile, *Polis Sentri, Galah Panjang* and *Baling Tin* reached at least 50% of their duration as vigorous-intensity activities. Similarly, Chow et al.[40] observed that 368 children aged 9–12 years spent at least 50% of MVPA during PE sessions engaging in sports such as rugby, volleyball and basketball.

Vector magnitude describes the patterns of movement involved while wearing an accelerometer. For each traditional game, motion is quantified in three axes, namely vertical, horizontal and perpendicular. Jumping is an example of motion in a vertical axis. The traditional game with the highest value in the vertical axis was *Bola Beracun* (Table 4) due to its similarity with the game of dodgeball, in which players must jump to avoid contact with the ball. *Galah Panjang, Baling Tin* and *Polis Sentri* also showed high value in vertical axis motions, which may be due to the need to jump in order to avoid being caught by the opponent's team or hit by the ball.

Meanwhile, moving side-to-side is an example of horizontal axis motions. The traditional game with the highest value in horizontal axis motion was *Belalang Belatuk,* which required the player to run sideways following the researcher's instructions. *Bola Beracun, Baling Tin* and *Galah Panjang* also showed high value in horizontal axis motion. This may be due to the characteristics of the games that also involve sideways motion while dodging the ball and the opponent team.

On the other hand, running forward is an example of motion in the perpendicular axis. The traditional game with the highest value of motion in the perpendicular axis was *Bola Beracun*; to win the game, players had to run to avoid being targeted by the opponent team. *Baling Tin* and *Galah Panjang* also showed a high value of motion in the perpendicular axis. This may be due to the games' rules whereby the players must run to catch the ball and reach the finishing area concomitantly.

Based on the results, the level of intensity of PA depends on the rules and regulations of the traditional games. Each traditional game has its own rules and guidelines, although the field size (i.e. playing space) and the duration of playing sessions are fixed. Additionally, the goal of each traditional game will put a different emphasis in terms of directions of motions involved and demands on motor skills, which further influence the number of step count, heart rate, MET and percentage of the level of intensity. Currently, no studies exist that accurately quantify the level of intensity of Malaysian traditional games. This is crucial because the level of intensity of traditional games may gauge our understanding regarding its impact on children's PA and health. Hence, the current study included the usage of an accelerometer to objectively and scientifically quantify the level of intensity for selected Malaysian traditional games. From these findings, traditional games that satisfied MVPA requirements can be applied as a school-based intervention to enhance children's daily PA.

Limitations and strengths of the study

Although accelerometers are reliable and valid instruments to evaluate children's PA levels, some activities such as upper-body motions may not be assessed accurately, which may lead to underestimated PA levels.[9] Another limitation of the present study was that all participants were sampled from a town in the northern regions of Malaysia; therefore, the findings may not be generalised to other demographic groups. Compared to previous studies, the research is novel in that the effects of playing space on the PA level of intensity were controlled while playing different traditional games. However, due to the limitations of the cross-sectional research design, findings from the current study must be interpreted with caution.

Conclusions

The level of intensity of six traditional Malaysian games was quantified scientifically using the accelerometer. The results showed that three traditional Malaysian games (i.e. *Bola Beracun, Galah Panjang* and *Baling Tin*) satisfied the requirement as MVPA in terms of step count, heart rate and vector magnitude in all axes. Hence, 20 min of playing traditional games may be a way to increase PA among primary school students.

Recommendations

The level of intensity of traditional games can be quantified objectively using the accelerometer and the methods employed in the current study. From the findings, three traditional Malaysian games (i.e. *Bola Beracun, Galah Panjang* and *Baling Tin*) satisfied the requirement for MVPA. Therefore, 20 min of playing traditional games—which can be incorporated in PE sessions—are recommended to increase PA among primary school students.

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Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

The Human Research Ethics Committee, Universiti Sains Malaysia has approved the study in principle [USM/JEPeM/280.5.(2.5)/ FWA Reg. No: 00007718; IRB Reg. No: 00004494 − 23-07-2014].

Authors contributions

MA conceived and designed the study, conducted research, provided research materials and collected and organised the data. MA and SS analysed and interpreted the data. MA, SS, BHAR and SMI wrote the initial and final drafts of the article. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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References

1. UNESCO. UNESCO. *Round table meeting on traditional sports and games*; 2006 http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SHS/pdf/final_report-Almaty.pdf. [Accessed 1 July 2019].
2. UNICEF. International inspiration. *Traditional games around the world report*; 2012 https://www.britishcouncil.org/society/sport/current-programmes/international-inspiration. [Accessed 1 July 2019].
3. Akbari H, Abdoli B, Shafizadeh M, Khalaji H, Hajihosseini S, Ziaee V. The effect of traditional games in fundamental motor skill development in 7-9 year-old boys. **Iran J Pediatr 2009**; 19(2): 123−129.
4. Petrovska S, Sivevska D, Cackov O. Role of the game in the development of preschool child. **Procedia Soc Behav Sci 2013**; 92: 880−884.
5. Varzani MR. A study of the role of games in the learning improvement of elementary schools in Karaj, Iran. **Procedia Soc Behav Sci 2013**; 84: 400−404.
6. Charles MAG, Abdullah MR, Musa RM, Maliki ABHM, Kosni NA. The effect of traditional games played with the rules intervention and regulations in-developing children's motor fitness abilities. **Man India 2017**; 97(22): 409−416.
7. Sharif R, Chong KH, Zakaria NH, Ong ML. Results from Malaysia's 2016 report card on physical activity for children and adolescents. **J Phys Activ Health 2016**; 13(S2): 201−205.
8. Troiano R, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. **Med Sci Sports Exerc 2008**; 40(1): 181−188.
9. Aljuhani O, Sandercock G. Contribution of physical education to the daily physical activity of schoolchildren in Saudi Arabia. **Int J Environ Res Publ Health 2019**; 16(13): 2397−2408.
10. Loprinzi PD, Davis RE, Fu YC. Early motor skill competence as a mediator of child and adult physical activity. **Prev Med Rep 2015**; 2: 833−838.
11. Armstrong N, Welsman JR, Kirby BJ. Longitudinal changes in 11-13 year-olds' physical activity. **Acta Paediatr 2000**; 89: 775−780.
12. Gallahue DL, Ozmun JC, Goodway JD. *Understanding motor development: infants, children, adolescent and adults*. 7th ed. Singapore: McGraw-Hill International Edition; 2012.
13. Zainuddin AA, Siti Nazirah MS, Lee MW, Kamaruzaman SAR, Goh KS, Saiful Islam AH, et al. The puberty profile of female adolescents in Cheras, Malaysia. **J Univ Malaya Med Centre 2018**; 21(2): 64−69.
14. Eaton DK, Kann L, Kinchen S, Shanklin S, Ross J, Hawkins J, et al. Youth risk behaviour surveillance: United States, surveillance summaries, morbidity and mortality weekly report. **MMWR Surveill Summ 2010**; 59(5): 1−142.

15. Freedson P, Pober D, Janz K. Calibration of accelerometer output for children. **Med Sci Sports Exerc 2005**; 37(11): S523–S530.
16. Fagenbaum A, Milliken L, Westcott WL. Maximal strength testing in healthy children. **J Strength Condit Res 2003**; 17: 162–166.
17. Geiger R, Willeit J, Rummel M, Hogler W, Stubing K, Strasak A, et al. Six-minute walk distance in overweight children and adolescents: effects of a weight-reducing program. **J Pediatr 2011**; 158(3): 447–451.
18. Biddle S, Armstrong N. Children's physical activity: an exploratory study of psychological correlates. **Soc Sci Med 1992**; 34(3): 325–331.
19. Vanhelst J, Béghin L, Salleron J, Ruiz JR, Ortega FB, Ottevaere C, et al. Impact of the choice of threshold on physical activity patterns in free living conditions among adolescents measured using a uniaxial accelerometer: the HELENA study. **J Sports Sci 2013**; 32(2): 110–115.
20. World Health Organization. *Global recommendations on physical activity for health*; 2015 http://apps.who.int/iris/bitstream/10665/44399/1/9789241599979_eng.pdf. [Accessed 1 July 2019].
21. Strong W, Malina R, Blimkie C, Daniels S, Dishman R, Gutin B, et al. Evidence based physical activity for school-age youth. **J Pediatr 2005**; 146(6): 732–737.
22. Guinhouya B, Samouda H, De Beaufort C. Level of physical activity among children and adolescents in Europe: a review of physical activity assessed objectively by accelerometry. **Publ Health 2013**; 127(4): 301–311.
23. Ekelund U, Sardinha L, Anderssen S, Harro M, Franks P, Brage S, et al. Associations between objectively assessed physical activity and indicators of body fatness in 9- to 10-y-old European children: a population-based study from 4 distinct regions in Europe (the European Youth Heart Study). **Am J Clin Nutr 2004**; 80(3): 584–590.
24. American College of Sports Medicine. *ACSM's guidelines for exercise testing and prescription*. 9th ed. Philadelphia: Lippincott Williams & Wilkins; 2014.
25. *United States report card on physical activity for children and youth*. National Report Card; 2014. http://www.physicalactivityplan.org/reportcard/. [Accessed 12 July 2019].
26. Sprengeler O, Wirsik N, Hebestreit A, Herrmann D, Ahrens W. Domain-specific self-reported and objectively measured physical activity in children. **Int J Environ Res Publ Health 2017**; 14(3): 242–253.
27. Belton S, Brady P, Meegan S, Woods C. Pedometer step count and BMI of Irish primary school children aged 6–9 years. **Prev Med 2010**; 50(4): 189–192.
28. Baquet G, Stratton G, Van Praagh E, Berthoin S. Improving physical activity assessment in prepubertal children with high-frequency accelerometry monitoring: a methodological issue. **Prev Med 2007**; 44(2): 143–147.
29. Cain K, Sallis J, Conway T, Van Dyck D, Calhoon L. Using accelerometers in youth physical activity studies: a review of methods. **J Phys Activ Health 2013**; 10(3): 437–450.
30. Freedson P, Melanson E, Sirard J. Calibration of the computer science and application, Inc. Accelerometer. **Med Sci Sports Exerc 1998**; 30(5): 777–781.
31. Trost S, Pate R, Sallis J, Freedson PS, Taylor WC, Dowda M, et al. Age and gender differences in objectively measured physical activity in youth. **Med Sci Sports Exerc 2002**; 34(2): 350–355.
32. Puyau M, Adolph N, Vohra F, Butte F. Validation and calibration of physical activity monitors in children. **Obes Res 2002**; 10(3): 150–157.
33. Treuth M, Schmitz K, Catellier D, McMurray R, Murray D, Almeida MJ, et al. Defining accelerometer thresholds for activity intensities in adolescent girls. **Med Sci Sports Exerc 2004**; 36(7): 1259–1266.
34. Mattocks C, Leary S, Ness A, Deere K, Saunders J, Tilling K, et al. Calibration of an accelerometer during free-living activities in children. **Int J Pediatr Obes 2007**; 2(4): 218–226.
35. Evenson K, Catellier D, Gill K, Ondrak KS, McMurray RG. Calibration of two objective measures of physical activity for children. **J Sports Sci 2008**; 26(14): 1557–1565.
36. Bassett D, Toth L, LaMunion S, Crouter S. Step counting: a review of measurement considerations and health-related applications. **J Sports Med 2017**; 47: 1303–1315.
37. Birch S, Duncan M, Franklin C. Overweight and reduced heart rate variability in British children: an exploratory study. **Prev Med 2012**; 55: 430–432.
38. Armstrong N. Young people's physical activity patterns as assessed by heart rate monitoring. **J Sports Sci 1998**; 16: S9–S16.
39. Winsley R. Cardiovascular function. In: Armstrong N, editor. *Paediatric exercise physiology*. United States: Churchill Livingstone Elsevier Limited; 2007. pp. 139–160.
40. Chow B, McKenzie T, Louie L. Physical activity and environmental influences during secondary school physical education. **J Teach Phys Educ 2009**; 28: 21–37.

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