Research in Physical Education, Sport and Health
2024, Vol. 13, No. 2, pp.33-37
ISSN(Print):1857-8152; ISSN(Online):1857-8160

WARM-UP APPROACH IN PHYSICAL EDUCATION CLASSES

DOI:
(Original scientific paper)

Petar Mihaylov
[1]Private school "D-r Petar Beron", Pedagogy, Physical education, Sofia, Bulgaria

Abstract

Warming-up is essential element of every physical activity. Our opinion is that the intermission between lessons is sufficient to ensure the base part of the warm-up, so when the students enter in the gym it is going to be time for the specific part of the warm-up. We included 14 girls and 16 boys 10-year-old from private primary school "D-r Petar Beron" in Sofia, Bulgaria. We conducted three measures in the gym – one before the class, one after "traditional" warm-up, and one after specific warm-up. We measured body temperature and heart rate. Our findings show that specific warm-up leads to higher body temperature(Girls: 36,2: Boys: 36,2) and heart rate(Girls: 141,6: Boys: 152,6) relative to basic warm-up(Girls: body temperature 35,7: heart rate 117,6: Boys body temperature 35,9: heart rate 117). There is no statistically significant difference between body temperature(Girls: 35,8: Boys:36,1) and heart rate(Girls: 113,5: Boys: 125,2) before the lesson and after the basic warm-up. This in our opinion means that intermissions of the lessons are relatively sufficient to ensure the basic part of the warm-up. More investigations are needed with better apparatus and methods.

Key words: *base warm-up, specific warm-up, traditional warm-up, heart rate, body temperature*

Introduction

Warming-up is fundamental element of every physical education class. According to Grajciarova (2024) the duration of the warm-up in physical education lesson is 6.2 minutes. The most used are stretching and dynamic mobilization exercises (Kahraman, 2023). Less used are specific exercises, which are related with main part of the lesson. "Warm-up is defined physical or mental activity to prepare the body for demand of physical activities and prevent injuries" (Unlu et all., 2023).

The "traditional warm-up" has some limitations. According to Cornwell et all (2001) static stretching has negative effect on power and speed abilities. The same is found in children (Faigenbaum, Mcfarland, 2007). Schrier (2005) says that static stretching do not prevent from injuries when it is implemented in warm-up. According to Jeffreys (2018) there is little direct evidence to demonstrate that a warm-up will reduce injury risk. In this way, a well-constructed warm-up is likely to have a slightly positive or at least neutral effect on injury risk. Investigation shows that vigorous warm-up protocols influence positive power and speed abilities in children and adults (Faigenbaum, 2006). As to Okobi (2022) 3,5 million sport injuries every year happens in a population younger than 18 years old. So major task of physical education teachers is to use proper exercises that prevent injury.

Warm-up should raise body temperature, heart rate, and other physiological components which improve the performance. Some authors implement different warm-up protocols like intermittent warm-up protocol (Inbar 1975), high-intensity warm-up protocol (Zois et all., 2015), dynamic warm-up protocol (Faigenbaum 2006), and etc. The main thing is that every author suggest vigorous intensity in warm-up which improves the consequent performance. Marban et all (2021) found that dynamic stretching better influence standing long jump results relative to static stretching.

It is known that higher muscle temperature facilitate oxygen release which influences better function on aerobic system, thus efficient energy expenditure.

Some authors implement small-sided games in warm-up activities with children (Zois et all., 2015, Unlu et all., 2023). We think small-sided games should be used in warm-up protocols in physical education classes, because it leads to raised physiological processes, which leads to better performance, also known as warm-up. Small-sided games affects every system of the human body, thus influencing global adaptation. On the other hand, stretching has impact only on activated muscle, thus leading to local adaptation.

Ciuelea et all (2019) implemented aerobics in warm-up protocols in physical education and found higher vital capacity as double as control group.

In our opinion dynamic protocols like small-sided games and RAMP warm-up (Jeffreys 2018) are correct approach when considering warm-up in physical education classes. Such protocol leads to specific attunement in nervous and muscle systems which lead to better performance on sequenced tasks. According to Gunawan et all (2023) a dynamic warm-up can increase motivation for participation in physical education classes with 91%. Therefore a 6 minutes dynamic warm-up will contribute 30 minutes per week if there is physical education lesson every day. That is 120 additional minutes per month which can better influence motor abilities in students. These additional minutes are great opportunity to develop skills and motor abilities like reaction time, coordination abilities, and etc. tThus the teacher will have greater impact on students without even one additional minute to the lesson time. According to Marban et all (2021) 8 minutes warm-up has better influence relative to 12-15 minutes warm-up routines.

Jeffreys (2018) says that if a warm-up is well-constructed, the students should be unable to differentiate between when the warm-up ends and the main training session starts.

Our aim in this investigation was twofold. First, we aimed to know if small-sided game approach better influences physiological components of the warm-up, like body temperature and heart rate compared to a traditional warm-up protocol. Second, we wanted to see is the activity in intermissions between classes sufficient to ensure the base part of the warm-up.

Material & methods

In this investigation were concluded 30 participants of which 14 girls and 16 boys. They were 11-years-old (5^{th} grade). The investigation was held in private primary school "D-r Petar Beron". It is important to mention that the measurement in the beginning of the lesson was after an intermission which is 15 minutes. The students are free to do what they want in these 15 minutes between lessons, and there are sport facilities which encourage them to be active (football pitch, basketball, and volleyball court).

It was used the pedagogical experiment method. Body temperature (BT) and heart rate (HR) was measured three times. First, BT and HR was measured in front of the gym immediately before the class began. The second measure was held after a "traditional" warm-up protocol. This protocol concluded 2 minutes jogging, dynamic stretching exercises – hand forward and backwards circles, body circles, forward and backward bend, left and right bend, knee circles, ankle circles. After, static stretching was held – seated forward bend, sitting single (butterfly), Kneeling leg extension, and lunge side bend. The duration of this protocol was approximately 8 minutes. Measuring of BT and HR was not incorporated into the time of warming-up.

The third measure was held after a specific warm-up routine. The game "Pass" was included in this routine. The students were separated into two teams of 8 players. The game was played in the gym on 10x10m square. The object of the game was for each team to accomplish 5 passes to get a point. The duration of the game was 8 minutes. After every 2 minutes there was a time-out for 60 seconds. In this time the students were asked to refine their tactic. After that procedure BT and HR was measured.

Body temperature was measured with infrared thermometer "Microlife NC 100". Heart rate was measured on palpatory by the students on arteria carotis externa for 10 seconds. After that the data was multiplied by 6.

The temperature in the gym was 13^{o}.

Data was collected and processed with IBM SPSS STATISTIC 26.0, with descriptive statistic method, and paired simple t-test method.

Results

Referring to the girls (Table 1) mean BT before the class is $35,8^{o}$(SD= 0,3) , heart rate in the beginning of the lesson is 113,5 b/min (SD= 13,5). The data is similar to BT (35,7; SD= 0,2) and HR (117; SD= 17,4) after traditional warm-up. There is no significant difference between BT and HR in the beginning of the lesson (P=46,8%) and after a traditional warm-up protocol (P= 60,8%).

After a specific warm-up protocol BT (36,2; SD= 0,7) and HR (141,6; SD= 38,6) are logically higher. The inflated standard deviation gives us information that the range is bigger than standard deviation in HR before the class and after a traditional warm-up protocol. The differences between BT (P= 97,5%) and HR (P= 98,1%) in the beginning of the lesson and after a specific protocol are statistically significant. The

differences in BT (P= 97,9%) and HR (P= 97,4%) after a traditional protocol and a specific warm-up protocol also is statistically significant.

Table 1. Body temperature and heart rate data in girls

	Girls	n	**min.**	**max.**	$\overline{X}$	**SD**
BT	Before lesson	14	35	36,6	35,8	0,3
	Traditional	14	35	36,2	35,7	0,2
	Specific	14	34,6	37,1	36,2	0,7
HR	Before lesson	14	96	132	113,5	13,5
	Traditional	14	90	156	117,6	17,4
	Specific	14	72	216	141,6	38,6

The BT and HR data in boys is similar (Table 2). Mean body temperature before the lesson is 36,1 (SD= 0,3), and HR is 125,2 b/min (SD= 20,6). It is interesting that mean BT (35,9; SD= 0,3) and HR (117; SD= 26,1) are lower after a traditional warm-up protocol relative to the data before the lesson. The data is not statistically significant (BT= 79,5%: HR= 67,6%).
Mean BT (36,1; SD= 0,7) and HR (152,6; SD= 41,7) are logically higher after a specific warm-up protocol. The differences in HR (P= 99,5) between traditional and specific warm-up protocol is statistically significant, but differences in BT are not (P=86,7%). The differences in HR (P=97,2%) between specific protocol and in the beginning of the lesson also are statistically significant, but differences in BT are not (P=25,8%).

Table 2. Body temperature and heart rate data in boys

	Boys	n	**min.**	**max.**	$\overline{X}$	**SD**
BT	Before lesson	16	35	36,8	36,09	0,3
	Traditional	16	35	36,5	35,93	0,3
	Specific	16	34,2	37,3	36,16	0,7
HR	Before lesson	16	78	150	125,2	20,6
	Traditional	16	78	180	117	26,1
	Specific	16	84	216	152,6	41,7

Discussion

As we see from the tables above, body temperature in girls and boys is higher in the beginning of the lesson relative to a traditional warm-up protocol. Yet, these differences are insignificant, and not statistically significant. Interesting fact is the lack of statistically significant differences in data between beginning of the lesson and a traditional warm-up protocol. That in our opinion can be explained in two aspects.

First, in our opinion a traditional warm-up protocol has not the abilities to rise BT and HR in optimal range. After a traditional protocol mean HR was 117b/min. This in our opinion is not enough to ensure the "warm-up" effect on the students' organisms. According to Faigenbaum and Mcfarland (2007), HR after a traditional warm-up is 109b/min. As per Brennan normal heart rate in 11 years-old children is 70-120 b/min. this means that our HR values after a traditional warm-up protocol are not even higher than a normal HR zone in this age.

It is known that the rise in body temperature with 1^{o}C influences power and speed abilities with 2-5% (Thapa et all., 2022). That means in this aspect, after a traditional warm-up protocol there is no effect on power and speed abilities because there are no differences in BT both in girls and boys.

According to Davies and Maconochie (2009) the rise in body temperature with 1 centigrade increases the heart rate with 10 beats per minute. As to Kirschen (2019) for every increase in temperature by 1^{o}C, the HR increases approximately by 7b/min, but in children there is approximately 20b/min increase in heart rate after 1 centigrade increase in body temperature.

Our data showed there is correlation between HR and BT (0,6) in girls only after a specific warm-up protocol (P = 97,6%). There is not significant correlation in boys' values.

In table 2 is seen that the mean HR in the beginning of the lesson in boys is even higher than a traditional warm-up protocol.

Second, in our opinion the students are active enough in intermissions between lessons (bigger than 10 minutes) which ensures the base part of "warm-up" effect on their organism. HR and BT data after a 15 minutes intermission in the beginning of the lesson is similar to values after a traditional warm-up protocol. That drives us to say that the effect is similar. And if it is, then the teachers should rethink the warm-up protocol after an intermission (bigger than 10 minutes).

The main problem in traditional warm-up protocol in our opinion is the stretching exercises. They are mostly static and have local effect on muscles. They barely increase heart rate. Stretching exercises increase muscle temperature but in local aspect. It is known that static stretching has negative effect on power and speed abilities (Cornwell et all., 2001, Faigenbaum 2007). After meta-analysis with 26 610 individuals, Lauersen and Andersen concluded that stretching has no beneficial effect for injury prevention in sport.

On the other hand, a dynamic warm-up protocol has quite better effect on BT and HR both in girls and boys. As it is seen in table 1 and table 2, mean heart rate for girls is 141,6 b/min, and for boys 152,6 b/min. This is around 70% from maximum heart rate which can be named as "moderate" activity. According to Ding et all (2023) after a dynamic warm-up protocol (8 minutes) HR is higher than 75% for around 4 minutes relative to 1,8 minutes in a traditional warm-up protocol.

It is known that if a warm-up begins with high intensity physical activity this will increase lactate accumulation and fatigue will arise sooner. That is why every warm-up protocol has e "base" part, which is executed with light to moderate intensity. This ensures smoothly increase in BT and HR to prepare the body for higher intensity afterwards. In our opinion the physical activity in intermissions between lessons is enough to ensure the "base" part of a warm-up protocol.

Therefore, it is good a physical education lesson after a big intermission to start with specific part of a warm-up protocol. If a warm-up protocol is executed with specific exercises, with higher HR this will ensure better effect on education and development of physical qualities. This is 8 minutes of qualitative physical activity in every lesson. If there are 4 lessons in a week, there will be 32 minutes of qualitative physical activity every week, without even add a minute in the lesson protocol.

Some physical education teachers include instant activities as a warm-up (Shimon, 2011). They are fun, low-organized games that quickly get students moving and elevates heart rate. Such instant activity is tag games.

According to Jeffreys (2018) a dynamic warm-up protocol can contains exercises which influences technical learning, development of physical qualities, and cognitive development. As to Hammami et all., (2017) small-sided games (SSD) is one of the most used methods for developing physical fitness, technical, and tactical qualities. Mean heart rate after SSD is above 80% of maximum heart rate and lactate concentration around 6mmol/l. In our opinion SSD can be implemented in specific part of a warm-up with caution of the dosage.

Thapa et all., (2022) implement SSD in warm-up and conclude that a traditional warm-up protocol has better effect on speed abilities. But SSD protocol has better effect on coordination abilities, power, change of direction, technical, and tactical abilities. After meta-analysis, Okobi and Evbayekha (2022) found that dynamic warm-up protocol has beneficial effect on warm-up prevention.

After implementing a dynamic warm-up protocol with 10 years-old students, Ding et all., (2022) say that mean heart rate is 150b/min. as it is seen from table 1 and table 2 mean heart rate both for girls and boys is approximately the same as to Ding values.

Conclusions

Physical activity in intermissions between lessons is interesting aspect of whole physical activity of students. We found that the students are active enough in intermissions between lessons to ensure the "base" part of a warm-up protocol.

BT and HR values in boys in the beginning of the lesson are even higher relative to a traditional warm-up protocol. Values in girls are approximately the same.

A dynamic warm-up protocol ensures higher values of BT and HR on students. In this case it is good a physical education lesson to start with a specific warm-up protocol. This is a chance to target the attention on educational part of the exercises and development of physical qualities. And if there are 8 minutes of qualitative physical activity in the beginning of the lesson, there will be 32 minutes every week, if there are

4 lessons (40 min.) per week. That is 128 minutes of qualitative physical activity every month. 128 minutes are approximately 3 lessons of physical education.

This investigation has some limitations. First limitation is sample size, which can influence the data from the measurements. Second, body temperature and heart rate are some of the warm-up criteria. In future investigations it should be included more criteria like joint mobility, reaction time, game performance. Third, we don't know what activity the students conducted in intermissions between lessons. Future investigations are needed to ensure information about what activity in intermissions are enough to ensure the "base" part of a warm-up protocol, also how much time is needed for these physiological changes in students' body to appear.

References

Ciuela, L., Szabo, B., Improving Students` Functional Capacity by Introducing Aerobics in the Warm-up Part of the Physical Education Lessons, 2019, *Studia Universitatis Babes-Bolyai Educatio Artis Gymnasticae*, 64(1), 45-53.

Davies, P. Maconochie, I. The Relationship Between Body Temperature, Hear Rate, and Respiratory Rate in Children, 2009, *Emergency medicine journal*, 26(9), 641-3.

Ding, L., Mackey, M., Li, S., Efficacy of a Neuromuscular Warm-up Program in Reducing the Risk of School Sports Injury Among Chinese Children: A Cluster Randomized Controlled Trial, 2023, *Orthopaedic journal of sports medicine*, 11(10).

Faigenbaum, A., Kang, J., DiFiore, M., Finnerty, C., Garcia, A., Cipriano, L., Bush, J., Ratamess, N., A Comparison of Warm-up Effects on Maximal Aerobic Exercise Performance in Children, *International journal of environmental research and public health*, 2022, 19(21), 14122.

Faigenbaum, A., Mcfarland, J., Guidelines for Implementing a Dynamic Warm-up for Physical Education, *Journal of physical education, recreation, and dance*, 2007, 78(3), 1-58.

Faigenbaum, A., Mcfarland, J., Schwerdtman, J., Ratamess, N., Kang, J., Hoffman, J., Dynamic Warm-up Protocols, With and Without a Weighted Vest, and Fintess Performance in High School Female Athletes, *Journal of athletic training*, 2006, 41(4), 357-63.

Grajciarova, L., The Position of the Warm-up in School Physical Education Lessons, *Physical education and training*, 2024, 17(2), 53-66.

Gunawan, G., Humaid, H., Junaidi, J., Dlis, F., Hambali, S., Muslimin, M., Fikri, A., The Effect of Warm-up Activities in Game-based Physical Education on Increasing Students Pulse, 2023, *International Journal of Human Movement and Sport Sciences*, 11(3), 598-603.

Hammami, A., Gabbett, T., Slimani, M., Bouhlel, E., Does Small Sided Games Improve Physical-Fitness and Specific Skills for Team Sports? A Systematic Review with Meta-Analysis, 2017, *The journal of sports medicine and physical fitness, 58(10), 1446-1455.*

Inbar, O., Bar, O., The Effects of Intermittent warm-up on 7-9 year-old Boys, *European journal of applied physiology and occupational physiology*, 1975, 34(2), 81-9.

Jeffreys, I., 2018, *The warm up: Maximize performance and improve Long-therm athletic development*, Human Kinetics.

Kahraman, K., Islen, T., Bilici, O., Sari, C., Bilici, M., The Effect of Different Warm-up on the Motor and Technical Skills of Handball Players of Spots Education, *Journal of educational issues*, 2023, 9(1), 336-348.

Kirschen, G., Singer, D., Thode, H., Singer, A., Relationship between body temperature and heart rate in adults and children: A local and national study, *The American journal of emergency medicine*, 2019, 38(5), 158-355

Marban, R., Fuentes, V., Torres, M., Mayorga, D., Static vs Dynamic-bouncing Warm-up in Schoolchildren, 2021, *Biology of sport*, 38(3), 333-339.

Najvar, P., Najvarova, V., Janik, T., Lesson Structure in Different School Subjects in the Czech Republic, *Orbis Scholae*, 2009, 3(2), 113-127.

Shimon, J., 2011, *Introduction to teaching physical education*, Human Kinetics.

Thapa, R., Clemente, F., Moran, J., Garcia, F., Scanlan, A., Ramirez, R., Warm-up Optimization in Amateur Male Soccer Players: A Comparison of Small-Sided Games and Traditional Warm-up Routines on Physical Fitness Qualities, 2022, *Biology of sport*, 40(1), 321-329.

Unlu, H., Ozdek, B., Filiz, B., Konukman, F., Teaching Developmentally Appropriate Warm-up Drills in Physical Education, *Journal of Physical Education, Recreation & Dance*, 2023, 94(6), 67-68.

Zois, J., Bishop, D., Aughey, R., High-Intensity Warm-ups: Effects During Subsequent Intermittent Exercise, *International journal of sport physiology and performance*, 2015, 10(4), 498-503.