Journal of Engineering Science and Technology
Vol. 18, No. 1 (2023) 453 - 462

TECHNOLOGY'S INFLUENCE ON PATTERN OF PHYSICAL ACTIVITY AND SEDENTARY BEHAVIORS AMONG EARLY CHILDHOOD

NUR INDRI RAHAYU*, ADANG SUHERMAN, JAJAT, KUSTON SULTONI, M. MUKTIARNI, RINA MARYANTI

Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229, Bandung, Indonesia
*Corresponding Author: nurindrirahayu1910@upi.edu

Abstract

Sedentary behavior among early childhood using ActiGraph accelerometer technology to measure their daily physical activity for seven days. This cross-sectional study was conducted among 147 early childhoods under five years old. The instrument used is ActiGraph accelerometer technology to detect and monitor children's physical activity patterns for a whole day and simultaneously as a data collection tool for their physical activity. ActiLife 6 is a software for data analysis and data recorded on ActiGraph. The data extraction is analysed using an independent sample t-test to test the differences in physical activity patterns in children based on gender and location of residence variables. The results showed there is no significant difference between the variables of height, weight, body mass index (BMI), screen time, and total sleep based on gender ($p > 0.05$). Meanwhile, the entire physical activity (TPA) and moderate to vigorous physical activity (MVPA) between boys and girls were significantly different ($p < 0.05$). The average TPA and MVPA of boys were higher than girls. The analysis of differences s based the d on the location of residence for all variables is the differences between boys and girls who live in rural areas and those who live in urban areas. Physical activity among children could be influenced by parents' educational level and electrical devices as a tool to predict their physical activity pattern. The study recommends developing global 24-hr movement guidelines for the early years to increase awareness of healthy levels and behaviors in the early years.

Keywords: ActiGraph accelerometer, Early childhood, Physical activity, Technology use.

1. Introduction

The early year's children, defined as 0-5 years old, is a sensitive and critical period for developing crucial physical activity and social, cognitive, and motor skills. considers the physical and motor development of young children in the way they move throughout the day. these activities are usually a combination of sleeping, standing, sitting, and other physical activity of varying intensity. At present, there are no guidelines regarding international movements for the early years. These are specific recommendations from the Report of the WHO Commission to End obesity in Childhood [1]. Currently, a look at the prevalence of overweight and obesity in countries where there is no data on delayed development of gross and fine motor skills. There is also evidence, obtained from several countries, that the prevalence of developmental delay in other outcomes considered important in the domain of motor and physical development is high, around 15% for gross motor skills, even up to 32% for fine motor skills [2-5].

This is problematic for many countries, especially Low- and Middle-Income Countries (LMICs), in these countries the awareness and behavior of the importance of health, especially in early years children, is still low. benchmarks and standards to determine the prevalence is still lacking. Several countries, in Australia, America, Great Britain, and New Zealand have created and developed physical activity guidelines for early years children. Canada and Australia have gone a step further and, in November 2017, released 24-hour integrated movement guidelines, which also include sleep [6, 7]. Preliminary data collected from Canada and Australia shows that only about 15% of preschool-age children (3-4 years) meet the three WHO recommended daily movement guidelines, namely: i) do at least 180 minutes of physical activity, at least 60 minutes engage in active games, ii) screen time does not exceed 60 minutes, and iii) quality sleep time must be between 10 and 13 hours. [8, 9]. the low level of physical activity carried out causes an increased risk of poor health and development of children [10, 11] and the potential for increasing human resources becomes less [12].

Physically active is recommended for early childhood, including an accumulation of at least 60 minutes or more of Moderate to Vigorous Physical Activity (MVPA) involving various aerobic Activities. Besides the MVPA, Vigorous Physical Activity (VPA), muscle and bone strengthening activities should incorporate at least three days/per week. Regarding sedentary behavior, every child is encouraged to minimize this activity. Sedentary behavior is the time that children spent to engage in screen time or sitting per day and should be monitored by an instrument. Uninterrupted 9 to 11 hours of sleep in step with nighttime for the children aged 5–13 years, and 8 to 10 hours consistent with night time for the ones aged 14 –17 years. The common sleep duration in step with nighttime is 9 to 11 hours or 8 to 10. Respectively, the evidence (upon which the guideline is in each student) is predominantly made from research that used common sleep length in step with the night of their analyses. a mean lets in for some ordinary variability. there may be no unique size of the consistent bed and wake-up time; a metric that assesses the consistency of bedtime and wake-up time is not always present daily.

The average sleep duration per night is 9 to 11 hours or 8 to 10, respectively. The evidence upon which the guideline is based is predominantly comprised of studies that used average sleep duration per night in their analyses. An average allows for some normal day-to-day variability. There is no specific measurement

of consistent bed and wake-up time; a metric that assesses the consistency of bedtime and wake-up time is not currently available.

For these reasons, it is essential to collect surveillance data using the new global 24-hr integrated movement guidelines as benchmarks in various countries, especially Indonesia. This will provide the first such international data for the early years and help the global community move towards preventing young children from developing obesity and ensuring they reach their developmental potential. The 24-Hour Movement Behavior for Children and Youth: An Integration of Physical Activity, Sedentary Behavior, and Sleep represents a paradigm shift in thinking about daily movement behaviors. This fundamental shift from focusing on movement behaviors in isolation to the concept that "the whole day matters" is strongly supported by the available evidence. Consideration of all behaviors along the movement continuum as a collective is warranted and holds promise in promoting population health. These are strong recommendations; the potential benefits of following these guidelines far exceed the potential risks. It is hoped that these guidelines open new avenues for population health promotion and instigate new research on the health effects of integrated movement behaviors. Due to the problem statement above, an instrument is needed to monitor all children's activities in one full day. This needs to be done to monitor the overall physical activity data of the children so that it can be adequately recorded and meet the principles of validity and reliability. To carry out valid and reliable recording, we need a tool with the right and appropriate technology elements to measure children's physical activity, including MPVA, VPA, and screen time, objectively and in real-time.

Children are increasingly interested in the latest forms of technology [13]. At this time, the popularity of smartphones and tablets and the use of such technological devices have become unavoidable, even now seen as an integral part of life. This device can be a unique attraction for children so that it can motivate them to use them, and indirectly this tool also performs its function of recording all their physical activities. Children even think of this as a toy or tool that seems to make them become superheroes and so on. ActiGraph is a technological device with procedures to record and integrate all events and activity levels of limb movements from time to time. The ActiGraph device can be worn on the wrist, ankle, or waist, relatively unobtrusive if used for several days or weeks. In addition to its function as a recording device for physical activity, the ActiGraph provides consistent objective data from sleep records of adult patients and pediatric patients suspected of or diagnosed with insomnia, circadian rhythm sleep-wake disorders, breathing disorders during sleep, central disorders of hypersomnolence, and adults with insufficient sleep syndrome [13].

The use of ActiGraph accelerometers in physical activity research has been overgrown in recent years [14]. To measure the level of physical activity, data are usually obtained from the vertical axis of the ActiGraph accelerometer worn at the waist and converted to the number of minutes per day spent in various physical activities. Another metric that can be estimated from an accelerometer and reflects the energy expended in physical activity is energy expenditure. Several predictions for estimating energy expenditure can also be recorded based on data from accelerometers [15]. This prediction was developed using indirect calorimetry as a comparison to convert the calculation of accelerometer activity into energy expenditure [16, 17].

2. Method

This cross-sectional study lasted eight months and was conducted in west java, Indonesia. ActiGraph is used by children for five full days without being released and under the help and supervision of parents in terms of its use at home. The subject of this research is early Childhood ages between 4-5 years; as many as 147 children come from several preschools in the West Java region. In terms of taking data on the subject, the researcher involved parents, and their willingness to be a participant was proven through informed consent—the pattern of research design, as seen in Fig. 1.

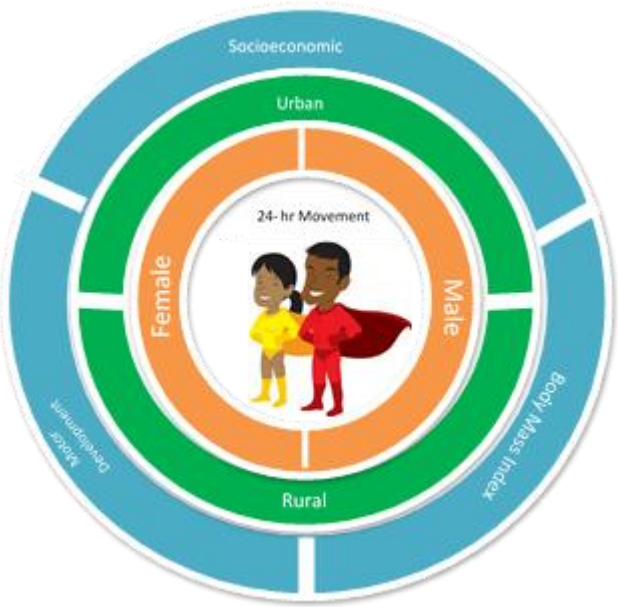

Fig. 1. Research design.

Twenty-four-hour movement behaviors (physical activity, sedentary time, and sleep) will be assessed using a technology device, namely an accelerometer ActiGraph. The type of ActiGraph used is GT3XP-BTLE; the device is also supported by ActiLife 6 single as software to read and analyse the data in ActiGraph. The data collector will be trained to use an ActiGraph to measure movement behaviors in this age group. Children will be asked to wear an ActiGraph continuously (including sleeping) for a minimum of seven days. Parents/careers will report their child's use of electronic media, sleep quality, and restrained sedentary time. Socio-demographic data will be collected from parents/careers using a modified version of the WHO STEPS Survey. The researcher undertook an initial shortlisting of all proposed secondary outcomes, instruments, and protocols. These included:

(i) Height and weight (used to calculate body mass index (BMI)) - measured using standardized procedures (as per WHO protocols).

(ii) Motor Development – Ages and Stages Questionnaire (3rd ed.). This has been translated into Zulu, Spanish, French, and Chinese.

(iii) Executive Function – Early Years Toolbox. Translated into four South African languages and Japanese.

To examine differences in children's physical activity patterns and sedentary behavior based on their gender and location of residence, the researcher used an independent sample t-test analysis with a significance level of 0.05.

3. Results

The results of independent sample t-test analysis showed that there was no significant difference between boys and girls in the variables of height, weight, BMI, screen time, and total sleep ($p > 0.05$). Meanwhile, the entire physical activity (TPA) and MVPA between boys and girls were significantly different ($p < 0.05$). The average TPA and MVPA of boys were higher than girls. Based on the location of residence, there is no difference between children who live in rural areas and those who live in urban areas on the variable of height, weight, BMI, screen time, total sleep, MVPA, and VPA ($p = 0.05$). All the research results can be seen in Tables 1 and 2.

Table 1. The pattern of physical activity is based on gender.

		Levene's Test for Equality of Variance		t-test for Equality of Means	
		F	**Sig.**	**t**	**Sig. (2-tailed)**
Height	**Equal variances assumed**	0.653	0.420	0.624	0.534
	Equal variances not assumed			0.627	0.532
Weight	**Equal variances assumed**	0.034	0.855	0.726	0.469
	Equal variances not assumed			0.726	0.469
BMI	**Equal variances assumed**	0.004	0.947	0.638	0.524
	Equal variances not assumed			0.639	0.524
TPA	**Equal variances assumed**	1.478	0.230	2.448	0.018
	Equal variances not assumed			2.448	0.018
MVPA	**Equal variances assumed**	0.476	0.493	3.291	0.002
	Equal variances not assumed			3.291	0.002
Screen Time	**Equal variances assumed**	6.356	0.013	1.486	0.140
	Equal variances not assumed			1.409	0.162
Total Sleep	**Equal variances assumed**	1.225	0.270	-0.708	0.480
	Equal variances not assumed			-0.699	0.486

Table 2. The pattern of physical activity is based on the location of residence.

		Levene's Test for Equality of Variance		t-test for Equality of Means	
		F	**Sig.**	**t**	**Sig. (2-tailed)**
Height	Equal variances assumed	0.061	0.806	1.678	0.096
	Equal variances not assumed			1.605	0.112
Weight	Equal variances assumed	0.458	0.500	1.266	0.208
	Equal variances not assumed			1.315	0.191
BMI	Equal variances assumed	1.170	0.281	0.727	0.469
	Equal variances not assumed			0.788	0.432
TPA	Equal variances assumed	1.793	0.187	0.182	0.856
	Equal variances not assumed			0.152	0.882
MVPA	Equal variances assumed	3.446	0.069	0.468	0.642
	Equal variances not assumed			0.365	0.723
Screen Time	Equal variances assumed	3.780	0.054	1.630	0.106
	Equal variances not assumed			1.788	0.076
Total Sleep	Equal variances assumed	0.024	0.876	0.457	0.648
	Equal variances not assumed			0.460	0.646

4. Discussion

This research showed a significant difference in TPA and MVPA in early childhood based on gender, where boys were more active than girls. Although some previous studies related to action based on gender in children under five years were relatively limited [18], some research found that children in elementary school reveal that boys are more active than girls. However, this study estimated that other factors affect children's physical activity, namely environmental factors [19]. Another study revealed that girls in rural areas are more motivated to do physical activity than boys [20]. These findings can be used as an illustration for further research by adding other variables and, on a larger scale

Based on the residence location, this research found no difference between children who live in rural areas and those who live in urban areas in physical activity. This result contrasts previous studies, which described that children who live in rural areas are less physically active than those who live in urban areas [21]. Other studies reveal that children who live in rural areas are more physically active than those who live in urban areas [22]. Previous studies also showed that children

who live in urban areas spend less time in sedentary activities than those who live in rural areas [23]. This study is aligned with the survey on young people in America; those who live in rural areas spend more time watching tv and using a computer than those who live in urban areas [24].

This study is important to understand physical activity in children. Additional understanding through education is needed. This is in line with current literature on the need for education to children to improve their understanding [25-41].

5. Conclusion

This research concludes that there is a significant difference in physical activity in early childhood based on gender, where boys are more physically active than girls. This study also concludes that there is no difference in physical activity in rural and urban areas in early childhood. In this research, gender is predicted to be the most substantial variable compared to the location of residence (Rural-Urban).

References

1. Phulkerd, S.; Nakraksa, P.; Mo-suwan, L.; Lawrence, M. (2021). Progress towards achieving the recommendations of the commission on ending childhood obesity: A comprehensive review and analysis of current policies, actions and implementation gaps in Thailand. *Nutrients* 13(6), 1-14.
2. Veldman, S.L.; Jones, R.A.; Chandler, P.; Robinson, L.E.; and Okely, A.D. (2020). Prevalence and risk factors of gross motor delay in pre-schoolers. *Journal of Paediatrics and Child Health*, 56(4), 571-576.
3. Okely, A.; Howard, S.; De Rosnay, M.; Mackie, F.; C Veldman, S.L.; and Melhuish, T. (2017). Relationships between motor skill delay and executive functions in vulnerable children aged 3-5 years. *Journal of Sport and Exercise Psychology*, 39, S34.
4. Bello, A.I.; Quartey, J.N.; and Appiah, L.A. (2013). Screening for developmental delay among children attending a rural community welfare clinic in Ghana. *BMC Pediatrics*, 13(1), 1-7.
5. Wei, Q.W.; Zhang, J.X.; Scherpbier, R.W.; Zhao, C.X.; Luo, S.S.; Wng, X.L.; and Guo, S.F. (2015). High prevalence of developmental delay among children under three years of age in poverty-stricken areas of China. *Public Health*, 129(12), 1610-1617.
6. Okely, A.D.; Ghersi, D.; Hesketh, K.D.; Santos, R.; Loughran, S.P.; Cliff, D.P.; Shilton, T.; Grant, D.; Jones, R.A.; Stanley, R.M.; Sherring, J.; Hinkley, T.; Trost, S.G.; MbHugh, C.; Eckermann, S.; Thorpe, K.; Waters, K.; Olds, T.S.; Mackey, T.; Livingstone, R.; Christian, H.; Carr, H; Verrender, A.; Pereira, J.R.; Zhang, Z.; Downing K.L.; and Tremblay, M.S. (2022). A collaborative approach to adopting/adapting guidelines - The Australian 24-hour movement guidelines for the early years (birth to 5 years): An integration of physical activity, sedentary behavior, and sleep. *BMC public health*, 17(5), 167-190.
7. Tremblay, M.S.; Chaput, J.P.; Adamo, K.B.; Aubert, S.; Barnes, J.D.; Choquette, L.; and Carson, V. (2017). Canadian 24-hour movement guidelines for the early years (0–4 years): an integration of physical activity, sedentary behavior, and sleep. *BMC Public Health*, 17(5), 1-32.

8. Cliff, D.P.; McNeill, J.; Vella, S.A.; Howard, S.J.; Santos, R.; Batterham, M.; and De Rosnay, M. (2017). Adherence to 24-hour movement guidelines for the early years and associations with social-cognitive development among Australian preschool children. *BMC Public Health*, 17(5), 207-215.
9. Chaput, J.P.; Colley, R.C.; Aubert, S.; Carson, V.; Janssen, I.; Roberts, K.C.; and Tremblay, M.S. (2017). The proportion of preschool-aged children meeting the Canadian 24-hour movement guidelines and associations with adiposity: Results from the Canadian health measures survey. *BMC Public Health*, 17(5), 147-154.
10. Poitras, V.J.; Gray, C.E.; Janssen, X.; Aubert, S.; Carson, V.; Faulkner, G.; and Tremblay, M.S. (2017). A systematic review of the relationships between sedentary behavior and health indicators in the early years (0–4). *BMC Public Health*, 17(5), 65-89.
11. Chaput, J.P.; Gray, C.E.; Poitras, V.J.; Carson, V.; Gruber, R.; Birken, C.S.; and Tremblay, M.S. (2017). A systematic review of the relationships between sleep duration and health indicators in the early years (0–4 years). *BMC Public Health*, 17(5), 91-107.
12. Black, M.M.; Walker, S.P.; Fernald, L.C.; Andersen, C.T.; DiGirolamo, A.M.; Lu, C.; and Lancet. (2017). Early childhood development coming of age: Science through the life course. *The Lancet*, 389(10064), 77-90.
13. Radesky, J.S.; Schumacher, J.; and Zuckerman, B. (2015). Mobile and interactive media use by young children: The good, the bad, and the unknown. *Pediatrics*, 135(1), 1-3.
14. Smith, M.T.; McCrae, C.S.; Cheung, J.; Martin, J.L.; Harrod, C.G.; Heald, J. L.; and Carden, K.A. (2018). Use of actigraphy for the evaluation of sleep disorders and circadian rhythm sleep-wake disorders: An American academy of sleep medicine systematic review, meta-analysis, and grade assessment. *Journal of Clinical Sleep Medicine*, 14(7), 1209-1230.
15. Bassett, D.R.; Troiano, R.P.; McClain, J.J.; and Wolff, D.L. (2015). Accelerometer-based physical activity: Total volume per day and standardized measures. *Medicine and science in sports and exercise*, 47(4), 833-838.
16. Lyden, K.; Kozey, S.L.; Staudenmeyer, J.W.; and Freedson, P.S. (2011). A comprehensive evaluation of commonly used accelerometer energy expenditure and MET prediction equations. *European Journal of Applied Physiology*, 111(2), 187-201.
17. Freedson, P.S.; Melanson, E.; and Sirard, J. (1998). Calibration of the computer science and applications, inc. accelerometer. *Medicine and Science in Sports and Exercise*, 30(5), 777-781.
18. Sääkslahti, A.; Numminen, P.; Varstala, V.; Helenius, H.; Tammi, A.; Viikari, J.; and Välimäki, I. (2004). Physical activity is a preventive measure for early childhood coronary heart disease risk factors. *Scandinavian Journal of Medicine and Science in Sports*, 14(3), 143-149.
19. Finn, K.; Johannsen, N.; and Specker, B. (2002). Factors associated with physical activity in preschool children. *Journal of Pediatrics*, 140(1), 81-85.
20. Amiri, P.; Naseri, P.; Vahedi-Notash, G.; Jalali-Farahani, S.; Mehrabi, Y.; Hamzavi-Zarghani, N.; and Khalili, D. (2020). Trends of low physical activity

among Iranian adolescents across urban and rural areas during 2006–2011. *Scientific Reports*, 10(1), 1-7.

21. Al-Nuaim, A.A.; Al-Nakeeb, Y.; Lyons, M.; Al-Hazzaa, H.M.; Nevill, A.; Collins, P.; and Duncan, M.J. (2012). The prevalence of physical activity and sedentary behaviors relative to obesity among adolescents from Al-Ahsa, Saudi Arabia: Rural versus urban variations. *Journal of Nutrition and Metabolism*, 2012(2), 1-9.
22. Liu, J.H.; Jones, S.J.; Sun, H.; Probst, J.C.; Merchant, A.T.; and Cavicchia, P. (2012). An urban and rural comparison is diet, physical activity, and sedentary behaviors as risk factors for childhood obesity. *Childhood Obesity (Formerly Obesity and Weight Management)*, 8(5), 440-448.
23. Machado-Rodrigues, A.M.; Coelho-E-Silva, M.J.; Mota, J.; Padez, C.; Martins, R.A.; Cumming, S.P.; and Malina, R.M. (2014). Urban-rural contrasts in fitness, physical activity, and sedentary behavior in adolescents. *Health Promotion International*, 29(1), 118-129.
24. Carson, V.; Iannotti, R.J.; Pickett, W.; and Janssen, I. (2011). Urban and rural differences in sedentary behavior among American and Canadian youth. *Health and Place*, 17(4), 920-928.
25. Manosa, C.; Pineda, C.K.; Namora, J.J.; and Daga-as, C. (2022). Health status of bachelor of physical education degree students amidst the covid-19 pandemic. *Indonesian Journal of Multidiciplinary Research*, 2(2), 373-376.
26. Samson, A.B.; and Agboola, M.A. (2022). Correlates of physical activity and sedentary behaviour of academic and non-academic staff in University of Ilorin, Ilorin, Nigeria. *Indonesian Journal of Multidiciplinary Research*, 2(2), 381-388.
27. Morbo, E.A. (2021). Instructional materials and alternative teaching practices in physical education. *Indonesian Journal of Educational Research and Technology*, 1(2), 67-70.
28. Calixtro Jr, V.L. (2021). Health status and job performance of physical education instructors in higher education institutions. *Indonesian Journal of Educational Research and Technology*, 1(2), 71-76.
29. Escomes, E.L.; and Morbo, E.A. (2021). Factors affecting distance learning of the physical education students of Sultan Kudarat State University, Mindanao, Philippines. *Indonesian Journal of Educational Research and Technology*, 1(3), 87-94.
30. Ledesma, G.L.; Lampedario, K.D.; Pequierda, J.D.; and Calixtro, V.L. (2021). Online learning and academic performance of bachelor of physical education students. *Indonesian Journal of Educational Research and Technology*, 1(3), 135-140.
31. Escomes, E.L.; and Morbo, E.A. (2022). Factors affecting distance learning of the physical education students of Sultan Kudarat State University, Mindanao, Philippines. *Indonesian Journal of Educational Research and Technology*, 2(2), 109-116.
32. Bakinde, S.T. (2022). Physical fitness status of male, and female non-athlete in Nigeria. *Indonesian Journal of Educational Research and Technology*, 2(2), 123-132.

33. Coyoca, M.B.P.; Del Rosario, M.A.B.; Lazo, J.R.L.; Calixtro Jr, V.L.; and Edaño, L.B. (2022). Impact of gardening on physical and mental health in the midst of covid-19 pandemic. *Indonesian Journal of Community and Special Needs Education*, 2(2), 99-102.
34. Orzukulova S.O. (2023). Organization of extracurricular physical education at school and its role in the physical and mental improvement of students. *Indonesian Journal of Community and Special Needs Education*, 3(2), 73-84.
35. Rusyani, E.; Permana, S.; and Ragadhita, R. (2022). Attitudes of high special school students with hearing impairment to online adaptive physical education learning. *Indonesian Journal of Teaching in Science*, 2(1), 57-66.
36. Apriyatna, F.; Nandiyanto, A.B.D.; Kurniawan, T.; and Bilad, M.R. (2023). Analysis of physical fitness level elementary school students during the covid-19 pandemic. *ASEAN Journal of Science and Engineering Education*, 2(1), 103-110.
37. Marcaida, J.P. (2022). Physical and mental health struggles during the time of pandemic: An overview of domestic setting. *ASEAN Journal of Community and Special Needs Education*, 1(1), 23-28.
38. Hidayatullah, W.; Muktiarni, M.; Mupita, J. (2022). Analysis comparative of physical fitness of students with disabilities and normal students. *ASEAN Journal of Community and Special Needs Education*, 1(2), 69-74.
39. Sultanto, M.A.; Al Afghani, R.I.; Meisya, S.D.; Salsabila, I.A.; Rohimat, S.S.; Stephani, M.R. (2023). Physical education online class for students with hearing impairment during covid-19 pandemic. *ASEAN Journal of Community and Special Needs Education*, 2(1), 17-26.
40. Ilhomovich, I.A. (2022). Boxing training technology based on the level of physical development of children. *ASEAN Journal of Physical Education and Sport Science*, 1(1), 1-8.
41. Ulaboevich, B.G. (2022). Improving the effectiveness of the method of conducting physical education classes for students of grades 5-9 in hot climates. *ASEAN Journal of Physical Education and Sport Science*, 1(1), 35-44.