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Body Surface Area as a Predictor of Energy Expenditure During Moderate Physical Work: Evidence from Generation Z Students

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Abstract

This study examined Body Surface Area (BSA) as a predictor of Energy Expenditure (EE) during moderate physical work among Generation Z students. Anchored on physiological and biophysical concepts linking body size, metabolic demand, and energy utilization, the study employed a quantitative-correlational research design. It involved 100 Generation Z students enrolled in Biophysics classes at Mindanao State University-Sulu. A purposive sampling technique was used, and data were gathered through anthropometric measurements and standard physiological computations. Body Surface Area was computed using height and width measurements, while Energy Expenditure was estimated using the Metabolic Equivalent of Task formula. Descriptive statistics were used to summarize the respondents' profile, while Pearson's correlation coefficient was applied to determine the relationship between BSA and EE at the 0.10 level of significance. Findings showed that most respondents were female, mostly aged 21 to 24 years old, with a mean age of 22.9 years. The study revealed a strong, positive, and statistically significant relationship between Body Surface Area and Energy Expenditure, with $r = 0.753$ and $p < .001$. This indicates that students with larger body surface areas tend to expend more energy during moderate physical work. The study concluded that BSA may serve as a useful predictor of EE among Generation Z individuals. Future studies are recommended to include a more balanced gender distribution and additional variables such as body composition, fitness level, and lifestyle practices. The study supports SDG 3 on Good Health and Well-Being and SDG 4 on Quality Education by contributing to health assessment, physical activity planning, and scientific inquiry in Biophysics. Its sustainability impact lies in supporting public health and educational sustainability through evidence-based understanding of energy use among young adults.

Keywords: Body Surface Area, Biophysics, Energy Expenditure, Generation Z, Health Assessment, Moderate Physical Work, Physical Activity, Public Health Sustainability, Quality Education

1. Introduction

This study examines Body Surface Area (BSA) as a predictor of Energy Expenditure (EE) during moderate physical work among Generation Z students. Grounded in physiological and biophysical concepts, the study focuses on how body size, particularly BSA, relates to energy use during physical activity. The literature emphasizes that energy expenditure is affected by body size, metabolism, activity level, and physiological characteristics. However, limited local studies have examined this relationship among ordinary Gen Z university students during moderate physical work, creating a need for localized evidence that may support health, fitness and academic investigations among young adults.

All living organisms require energy to sustain essential body functions such as breathing, blood circulation, digestion, and cellular repair. Even at rest, the body continuously uses energy to maintain normal physiological processes (Davodits, 2008). During physical activity, additional energy is required to support movement and muscular work. The amount of energy needed varies according to body size and level of physical activity (McArdle, Katch, & Katch, 2015). Energy expenditure during physical activity is an important indicator of how the body uses energy to perform work. It is influenced by physiological factors such as age, sex, body composition, metabolic rate, and Body Surface Area (BSA) (Guyton & Hall, 2021). BSA refers to the total external area of the human body and is commonly used in medical and physiological studies to estimate metabolic functions, heat regulation, and caloric requirements (Mosteller, 1987). In biophysics, examining the relationship between BSA and Energy Expenditure helps explain how physical body characteristics affect energy consumption during activity (McArdle, Katch, & Katch, 2015).

The literature identifies BSA as an important physiological measurement because it reflects body size and composition. It is used to estimate metabolic rate, caloric needs, heat exchange, and drug dosage (Mosteller, 1987). Body size also influences circulation, thermoregulation, and metabolism, with larger individuals generally requiring more energy to support bodily functions and movement (Guyton and Hall, 2021). Compared with body weight alone, BSA may provide a more complete estimate of metabolic activity because it considers both height and weight. Energy expenditure refers to the amount of energy or calories used by the body to sustain physiological functions and perform activities. McArdle, Katch, and Katch (2015) explained that total energy expenditure includes basal metabolic rate, thermic effect of food, and physical activity energy expenditure. Among these components, physical activity contributes substantially to daily energy consumption because the body requires energy for muscular movement and cardiovascular function. Energy expenditure increases depending on the intensity and duration of physical work because greater oxygen consumption and muscular effort are needed to sustain movement (Astrand, Rodahl, Dahl, and Stromme, 2003). Body composition and body dimensions are also connected with metabolic demand. Heymsfield, Lohman, Wang, and Going (2005) emphasized that body mass and surface area affect energy requirements because larger individuals tend to have higher metabolic demands. As body size increases, the body needs more energy for temperature regulation, physiological maintenance, and movement. This supports the idea that individuals with larger body surface areas may expend more energy during moderate physical activities. Moderate physical work involves activities that require moderate effort and increase heart rate and breathing without causing excessive fatigue. According to the World Health Organization (2020), moderate physical activities improve cardiovascular endurance, muscular strength, and overall physical health. The American College of Sports Medicine (2021) also explained that regular moderate physical activity improves metabolic efficiency and supports better energy utilization.

Generation Z individuals, commonly identified as those born between the late 1990s and early 2010s, are often associated with lifestyles shaped by technology, reduced physical activity, and changing health behaviors (Twenge, 2017). Although digital and sedentary activities may influence their lifestyle patterns, moderate physical work remains part of the daily academic, recreational, and personal activities of university students. In the local academic setting, the study focuses on Generation Z Biophysics students at the university. The respondents were fourth-year Biology students enrolled in Biophysics classes under the supervision of the lead researcher. The study was conducted at Mindanao State University-Sulu and focused on moderate physical work activities among young adult students. This local context is important because limited studies have examined BSA and EE among ordinary college students, particularly in relation to moderate physical work.

The study is conceptually anchored on the physiological relationship between body size and metabolic demand. BSA represents the external surface area of the body and is linked with heat regulation, caloric requirements, and metabolic activity (Mosteller, 1987). Since larger body dimensions require greater energy for movement and physiological maintenance, BSA may influence the amount of energy expended during physical work (Guyton & Hall, 2021; McArdle, Katch, & Katch, 2015). The study also draws from the principle that physical activity energy expenditure increases when the body performs muscular movement and cardiovascular work. Energy expenditure depends on activity intensity, duration, and physiological characteristics such as body size and composition (Astrand, Rodahl, Dahl, and Stromme, 2003; Heymsfield, Lohman, Wang, and Going, 2005). These concepts support the investigation of whether BSA can predict EE during moderate physical activity.

Although BSA is widely used in medical and physiological studies, limited local studies have examined its relationship with energy expenditure among Generation Z university students during moderate physical work. Existing studies commonly focus on athletes, clinical populations or general metabolic measurements, leaving a gap in understanding how BSA influences EE among ordinary college students in local academic settings. This study addresses that gap by examining whether Body Surface Area can predict Energy Expenditure during moderate physical work among Gen Z Biophysics students. Specifically, it investigates the correlation between BSA and the amount of energy expended during moderate physical activity. The study aims to provide localized scientific evidence that may support future academic, health-related and exercise physiology investigations among young adults.

This study is aligned with SDG 3 – Good Health and Well-Being because it examines physiological factors related to physical activity, energy use, body size and health assessment among young adults. Its findings may support the development of more accurate physical activity programs, caloric expenditure assessments, and health-related interventions for Generation Z individuals. The study also supports SDG 4 – Quality Education because it contributes to scientific inquiry within a university setting, particularly in Biophysics and health-related education. By generating localized evidence involving students, the research may strengthen academic understanding of exercise physiology, energy metabolism and body-based predictors of energy expenditure.

The study contributes to public health sustainability by providing evidence that may help health professionals and fitness trainers consider body size and physiological characteristics when assessing caloric expenditure and physical activity

needs. It may support more individualized and appropriate health programs for young adults. It also contributes to educational sustainability by strengthening the use of scientific and biophysical inquiry in understanding student health, metabolism, and physical activity. The study may serve as a basis for future academic investigations in exercise physiology, health assessment, and energy metabolism among Generation Z students. From a multidisciplinary perspective, the study connects biophysics, physiology, health education, physical activity assessment, and youth wellness. Its value lies in showing how a measurable body characteristic, Body Surface Area, may help explain energy expenditure during moderate physical work among young adults.

2. Material and methods

2.1 Research Design

The study employed a quantitative-correlational research design to determine the relationship between Body Surface Area (BSA) and Energy Expenditure (EE) during moderate physical work among Generation Z students. This design was appropriate because the study aimed to identify the strength and direction of association between the two variables without manipulating any condition or treatment.

2.2 Locale of the Study

The study was conducted at Mindanao State University-Sulu, within the university premises in Patikul, Sulu, Philippines. Data collection was carried out during scheduled class activities and moderate physical work sessions from May 13, 2026 to May 14, 2026.

2.3 Respondents of the Study

The respondents were Generation Z students enrolled in Biophysics classes handled by the lead researcher at Mindanao State University-Sulu. They were considered appropriate participants because they belonged to the target Generation Z population and were directly involved in the moderate physical work activities required in the study.

2.4 Sample and Sampling Procedure

The study involved 100 Generation Z student respondents. A purposive sampling technique was used in selecting the participants. All students from the three Biophysics class sections handled by the lead researcher were included because they met the specific criteria relevant to the objectives of the study. This ensured that the respondents belonged to the intended population and were exposed to the required physical work activities.

2.5 Research Instrument

The study used anthropometric measurements and standard physiological computation procedures as data-gathering instruments. Height and weight measurements were obtained to compute the respondents' Body Surface Area (BSA) using the stated physiological formula, BSA = Height (in meter) x Width (in meter). Energy Expenditure (EE) during moderate physical work was measured and recorded using the standard Metabolic Equivalent of Task (MET) formula for physical activity assessment: EE = MET x Weight (kg) x Duration (hours). In this formula, EE refers to energy expenditure expressed in kilocalories, MET refers to the metabolic equivalent value of the activity performed, weight refers to the body weight of the respondent in kilograms, and duration refers to the length of activity performed in hours.

2.6 Data Gathering Procedure

Before the conduct of the study, the participants were informed about the purpose and objectives of the research, and voluntary participation was secured. Anthropometric measurements were collected to compute Body Surface Area, while Energy Expenditure during moderate physical work activities was measured and recorded. After data collection, the gathered information was organized and tabulated in Excel before statistical analysis.

2.7 Data Analysis Techniques

The data were analyzed using jamovi version 2.6.44. Descriptive statistics, including mean and standard deviation, were used to summarize the demographic profile and study variables. Pearson's correlation coefficient was used to determine the relationship between Body Surface Area and Energy Expenditure, including the strength and direction of the association between the variables, at the selected 0.10 level of significance.

2.8 Ethical Considerations

The study observed ethical standards in conducting research involving human participants. The respondents were informed about the purpose and procedures of the study, and their voluntary participation was secured through informed consent. They were also assured that they could withdraw from the study at any time without penalty. Confidentiality and privacy were maintained by keeping personal information and collected data anonymous and by using the data solely for academic purposes. The researchers also ensured that the moderate physical work activities did not expose participants to harm or unnecessary risk

3. Results and Discussion

3.1 Main Findings

3.1.1 Demographic Profile of the Respondents

The study involved 100 Generation Z respondents. In terms of gender, the majority were female, comprising 94 respondents or 94% of the total population, while only 6 respondents or 6% were male. The computed mean for gender was 1.94 with a standard deviation of 0.23, indicating that most respondents belonged to the female category. In terms of age, the respondents had a mean age of 22.9 years with a standard deviation of 1.81. Most respondents were 22 and 23 years old, with each age group representing 30% of the total respondents. This was followed by respondents aged 21 and 24, each comprising 14%, while smaller percentages were recorded for ages 25, 26, 27, 28, and 29. These findings show that the participants were generally young adults within the Generation Z population. The limited variation in age indicates that the respondents came from a relatively similar developmental group, which is appropriate for examining energy expenditure among Gen Z students during moderate physical work. The predominance of female respondents, however, suggests that the results mainly represent the physiological profile of the female student population included in the study.

3.1.2 Relationship Between Body Surface Area and Energy Expenditure

The results showed a strong positive relationship between Body Surface Area (BSA) and Energy Expenditure (EE) during moderate physical work. The computed Pearson's correlation coefficient was $r = 0.753$, indicating that as the respondents' body surface area increased, their energy expenditure also tended to increase. The p-value of $< .001$ was lower than the 0.10 level of significance; therefore, the null hypothesis stating that there is no significant relationship between Body Surface Area and Energy Expenditure was rejected. This result indicates that Body Surface Area is significantly associated with Energy Expenditure among Generation Z respondents during moderate physical work. Students with larger body surface areas generally required and utilized more energy while performing physical activities. This supports the physiological principle that individuals with greater body dimensions tend to have higher metabolic demands because movement, heat regulation, and normal bodily functions require energy. Since the respondents belonged to the same Generation Z age group, differences in energy expenditure were more likely related to body size and surface area rather than age alone.

3.1.3 Predictive Value of Body Surface Area

The findings suggest that Body Surface Area may serve as a useful predictor of Energy Expenditure during moderate physical work among Generation Z students. The strong and statistically significant positive correlation indicates that larger body surface area is associated with higher energy expenditure. This means that BSA can be considered an important physiological factor in estimating energy use during moderate physical activity. This finding has practical value in health assessment, physical activity planning, and exercise-related evaluation among young adults. Since BSA reflects body size, it may help educators, healthcare practitioners, fitness trainers, and researchers better understand how physiological characteristics influence energy use. The result also supports the use of body-based measurements in developing more appropriate physical activity and health programs for Generation Z individuals.

3.2 Summary of Findings

The study found that most respondents were Generation Z young adults, predominantly female, and mostly aged 21 to 24 years old. The findings also revealed a strong, positive, and statistically significant relationship between Body Surface Area and Energy Expenditure during moderate physical work, with $r = 0.753$ and $p < .001$. This confirms that respondents with larger body surface areas tended to expend more energy during physical activity. Overall, the results indicate that Body Surface Area is an important physiological factor associated with Energy Expenditure among Generation Z students. The findings provide evidence that BSA may be considered in evaluating energy needs, physical performance, and health-related interventions for young adults. Future studies may strengthen these findings by including a more balanced gender distribution and additional variables such as body composition, fitness level, and lifestyle practices.

4. Conclusion & Recommendations

The study concluded that the respondents were mostly Generation Z young adults, predominantly female, and generally aged 21 to 24 years old. The findings revealed a strong and statistically significant positive relationship between Body Surface Area (BSA) and Energy Expenditure (EE) during moderate physical work, indicating that individuals with larger body surface areas tend to expend more energy. Therefore, Body Surface Area may serve as a useful predictor of energy expenditure among Gen Z individuals during moderate physical work.

Future researchers are encouraged to include a more balanced distribution of male and female respondents to generate broader findings. Additional variables such as body composition, fitness level, and lifestyle practices may also be examined

to better understand the factors affecting energy expenditure. Educators and healthcare professionals may likewise consider Body Surface Area (BSA) in developing physical activity and health programs for Generation Z individuals.

The study was limited to Generation Z students and did not include participants from other age groups. It focused only on moderate physical work activities and excluded light and vigorous physical activities. Other variables such as dietary intake, lifestyle, medical conditions, environmental factors, and physical fitness level were not considered; therefore, the findings were based only on the responses and measurements obtained from the selected respondents and may not be generalized to other populations or settings.

Compliance with ethical standards

The study was conducted in accordance with institutional ethical standards for research involving human participants. The respondents were informed about the purpose and procedures of the study, participated voluntarily, and provided informed consent. They were assured of confidentiality, anonymity, and the right to withdraw without penalty. All data were used solely for academic purposes, and the moderate physical work activities were conducted without exposing participants to unnecessary risk. The authors declare that there is no conflict of interest, acknowledge all contributions to the completion of the study, and accept full responsibility for the integrity, authorship, and copyright compliance of the manuscript.

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