

# Establishing A Local Norm of Assessment for Arm Strength Using One-Repetition Maximum Push-Up Test in Bukidnon, Philippines

Jasiel Bacsarpa<sup>1</sup>, Oliver Napila Gomez<sup>2</sup>

<sup>1</sup>Lourdes College, Inc. Graduate School

<sup>2</sup>Mindanao State University – Maigo College of Education, Science and Technology

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## ABSTRACT

Standardized, population-specific norms enhance the reliability, validity, and fairness of fitness assessments by enabling accurate interpretation of test results across demographic groups. However, commonly used push-up test norms are largely repetition-based and generalized, limiting their applicability for adolescent populations with distinct developmental and contextual characteristics. This study aimed to establish normative standards for an estimated one-repetition maximum (1RM) push-up test using the Epley formula among high school students in Bukidnon and to determine whether estimated 1RM performance differs by age, gender, geographic location, and physical activity level. A cross-sectional descriptive-comparative design was employed, involving 998 public high school students (N = 998) who completed a standardized, cadence-controlled push-up protocol. Estimated 1RM push-up scores were derived using the Epley equation and analyzed using descriptive statistics and percentile cut-offs. Group differences were examined using appropriate comparative statistical tests for age, physical activity level, gender, and geographic location, with effect sizes reported. Results indicated significant differences in estimated 1RM push-up performance across age, gender, and geographic location, all with small effect sizes, while no significant differences were observed across physical activity levels. Based on percentile distributions, age-, gender-, and locale-specific strength norms were proposed, classifying performance into Poor, Fair, Good, Very Good, and Excellent categories. These findings support the use of estimated 1RM push-up norms as a safe and context-sensitive tool for assessing adolescent muscular strength and for informing school-based fitness evaluation practices. Future research is recommended to expand the norming process across broader populations, incorporate additional strength assessment methods for validation, and examine longitudinal changes in adolescent strength development.

**Keywords:** Estimated One-Repetition Maximum; Push-Up Test; Epley Formula; Normative Standards; Adolescent Fitness; Physical Education

## INTRODUCTION

Standardized norms are fundamental to the reliability, validity, and interpretability of physical fitness assessments, as they provide objective reference points for comparing individual performance across populations, demographic groups, and testing contexts (Mascherini et al., 2022; Zhang et al., 2021). In school-based Physical Education (PE), the push-up test is among the most frequently administered field tests for evaluating upper-body muscular strength and endurance due to its simplicity, low cost, and minimal equipment requirements. However, the meaningful interpretation of push-up performance depends heavily on the availability of appropriate normative standards that reflect the characteristics of the population being assessed.

Maximal strength is commonly operationalized through the one-repetition maximum (1RM), defined as the maximum load an individual can lift once with proper technique (Grgić et al., 2020). Although direct 1RM testing is considered a gold standard for strength assessment, it carries inherent risks, particularly for untrained individuals and youth populations, where improper execution, insufficient supervision, or inadequate conditioning may increase the likelihood of musculoskeletal injury (García-Ramos et al., 2021; Pierce et al., 2022). These risks have prompted the development and use of submaximal strength prediction equations, such

as the Epley formula, which estimates 1RM based on the load lifted and the number of repetitions performed to fatigue ( $1RM = Load \times [1 + 0.033 \times \text{repetitions}]$ ) (Macarilla et al., 2022). This approach allows practitioners to obtain valid strength estimates while minimizing the biomechanical and safety concerns associated with maximal testing.

Recent studies have extended the application of the Epley formula to bodyweight exercises, including the push-up test, demonstrating its practicality and predictive validity as a method for estimating upper-body muscular strength in school and athletic settings. Despite these advances, most existing push-up norms remain repetition-based and broadly generalized across age and sex categories, neglecting known developmental differences in strength performance during adolescence (Ajisafe, 2019). Repetition-based scoring further introduces validity concerns, as push-up performance is influenced by assessor judgment, testing conditions, movement cadence, and individual anthropometric factors (Artanayasa, 2023; Artanayasa et al., 2022; O’Keeffe et al., 2020). Notably, repetition counts are negatively associated with body mass index (BMI), which may disadvantage individuals with higher body mass despite adequate absolute muscular strength (Vodičar et al., 2020).

The absence of standardized, strength-based norms has important consequences for test interpretation and educational practice. Inaccurate or inconsistent scoring may lead to misclassification of fitness levels, inappropriate training prescriptions, and diminished learner motivation, particularly when students fail to meet benchmarks that do not account for developmental or contextual differences (Gomez, 2025). Moreover, the physical demands of the push-up test may discourage participation among less fit students, raising concerns regarding inclusivity and equitable assessment in PE contexts (Ajisafe, 2019). These limitations highlight the need for strength-focused, population-specific normative references that better reflect true muscular capacity.

Although the push-up test incorporating the Epley formula has recently undergone validation (Gomez, 2025), the development of corresponding normative standards remains limited, particularly in geographically and culturally distinct populations. Normative values for physical fitness tests are known to vary according to age, sex, and geographic context, underscoring the importance of localized reference standards in adolescent fitness assessment (Vanhelst et al., 2019). In the Philippine context, regional differences in lifestyle, physical activity exposure, and educational environments further necessitate the establishment of context-sensitive norms.

Accordingly, this study aims to contribute to the literature by establishing age-, gender-, and context-specific normative standards for the estimated 1RM push-up test using the Epley formula among high school students in the Province of Bukidnon. By addressing gaps in existing norming practices, the study seeks to enhance the validity, fairness, and practical utility of push-up-based strength assessment in school-based physical education and youth fitness monitoring.

In developing the norms among high school students in the province of Bukidnon, the following research questions were formulated: (1) What is the participants’ push-up test performance considering their demographics? (2) Do the estimated 1RM push-up test performances differ significantly when grouped in terms of age, gender, geographic location; and physical activity level, and (3) Based on assessment findings, what norms for strength can be proposed?

Moreover, hypotheses helped to determine the need to develop distinct standard norms that consider sex and activity status. Hence, the null hypotheses state that there are no significant difference in estimated 1RM push-up performance among participants grouped by age, gender, geographic location, and physical activity level.

## METHODS

This study employed a cross-sectional descriptive-comparative research design to examine estimated one-repetition maximum (1RM) push-up performance among high school students in the Province of Bukidnon. Cross-sectional designs are appropriate for describing performance characteristics and identifying group differences at a single point in time, particularly in educational and public health research where population profiling and normative reference development are required (Creswell & Creswell, 2023; Ngcobo et al., 2023). Descriptive approaches further allow for systematic documentation of patterns, variations, and distributions

within a population, especially when the primary aim is to characterize performance outcomes rather than establish causality.

Participants were selected using a stratified random sampling technique to ensure proportional representation across age groups, geographic locations, and physical activity levels. Stratified sampling reduces sampling bias and improves the generalizability of findings by accounting for population heterogeneity (Etikan & Bala, 2017; Ismail & Zainun, 2023). The target population consisted of public junior high school students (Grades 7–10) in Bukidnon, with schools drawn from three districts to capture geographic variation. A total of 998 students participated in the study. Inclusion criteria were: age between 12 and 18 years, written informed consent from a parent or guardian with student assent, and the absence of medical conditions that would contraindicate participation in moderate-to-vigorous physical activity. Exclusion criteria included diagnosed cardiovascular, respiratory, or musculoskeletal conditions, recent injuries that could impair performance, and refusal to provide consent or assent.

Prior to participation, all students completed the Physical Activity Readiness Questionnaire (PAR-Q) to screen for potential health risks. Students who responded affirmatively to any item were required to obtain medical clearance before testing. All test administrations were supervised by trained physical education teachers to ensure adherence to standardized procedures and participant safety.

Upper-body strength was assessed using a standardized push-up test protocol combined with the Epley equation to estimate one-repetition maximum strength (Epley, 1985). This method has been shown to provide valid estimates of maximal strength while minimizing the risks associated with direct 1RM testing (Gomez, 2025). Participants performed push-ups with hands positioned shoulder-width apart, feet together, and the body maintained in a straight alignment throughout the movement. A uniform cadence of three seconds per repetition (1.5 seconds downward and 1.5 seconds upward) was enforced using an audio metronome to standardize movement velocity. The test was terminated when the participant could no longer maintain proper form or cadence. The total number of correctly executed repetitions was recorded and used to estimate 1RM strength using the formula:  $\text{Estimated 1RM} = \text{Load} \times (1 + 0.033 \times \text{repetitions})$ .

Push-up load was calculated using a digital weighing scale to determine the proportion of body mass supported during straight-arm and bent-arm push-up positions, with the average load applied in the estimation equation. Automated calculations were verified using an HTML-based 1RM calculator to ensure accuracy. In addition to the push-up assessment, demographic information was collected through a structured profile form that included age, gender, geographic location (rural or urban), and self-reported physical activity level, classified into low active, active, or highly active categories using a Modified International Physical Activity Questionnaire for Adolescents. The Modified IPAQ for Adolescents was used solely for participant classification into activity groups and was not treated as a primary research variable.

Validity and reliability of the testing protocol were established through a pilot study conducted prior to full implementation. Content validity was evaluated by experts in exercise science and biomechanics to confirm that the protocol adequately measured upper-body strength and endurance. Test–retest reliability was assessed by administering the test on two occasions under similar conditions, yielding a test–retest reliability coefficient of 0.927, indicating a high level of measurement consistency in line with the  $\geq 0.70$  threshold recommended for field-based fitness tests. Feedback from the pilot phase was used to refine testing procedures and standardize administration (Gomez, 2025).

Ethical approval was obtained from the Lourdes College Research Ethics Committee prior to data collection, followed by formal permission from the Department of Education and participating school administrators. Orientation sessions were conducted to explain the study's purpose, procedures, potential risks, and benefits to students and their parents or guardians. Participation was voluntary, and students were informed of their right to withdraw at any time without penalty. Testing was conducted in designated school areas to ensure privacy and standardized conditions. Emergency protocols, including first-aid stations, hydration access, and trained personnel, were in place throughout data collection. Participant discomfort and fatigue were monitored, and a cooldown period followed testing sessions. All data were anonymized, securely stored, and accessible only to

authorized research personnel, in accordance with the Belmont principles of respect for persons, beneficence, and justice.

Collected data were encoded, screened, and analyzed using appropriate descriptive and inferential statistical procedures. Descriptive statistics, including frequency, mean, standard deviation, minimum, maximum, and range, were computed to summarize estimated 1RM push-up performance across demographic groups. Percentile values (P20, P40, P60, and P80) were calculated to support the development of normative reference standards. Group differences were examined using one-way analysis of variance (ANOVA) for age and physical activity level and independent-samples t-tests for gender and geographic location. When ANOVA yielded a significant main effect, post hoc pairwise comparisons were conducted using Tukey’s HSD test. Prior to inferential analysis, assumptions of normality and homogeneity of variances were assessed. When normality assumptions were violated, rank transformation was applied to estimated 1RM scores. Welch’s t-test was used when equality of variances was not met. Effect sizes were reported using eta squared ( $\eta^2$ ) for ANOVA and Cohen’s d for t-tests. Normative classifications were developed using untransformed estimated 1RM scores and percentile-based cut-offs, categorized as Poor ( $\leq P20$ ), Fair (P20–P40), Good (P40–P60), Very Good (P60–P80), and Excellent ( $\geq P80$ ). Statistical significance for all inferential analyses was set at  $\alpha = .05$  (two-tailed).

## RESULTS

Table 1 presents the descriptive statistics of participants’ estimated one-repetition maximum (1RM) push-up performance across age, gender, physical activity level, and geographic location. Overall, the participants (N = 998) demonstrated a mean estimated 1RM push-up performance of 39.05 kg (SD = 8.57), with values ranging from 16.93 kg to 68.85 kg. The wide score range (51.92 kg) indicates substantial interindividual variability in upper-body pushing strength within the adolescent population.

**Table 1 Descriptive Statistics of Estimated 1RM Push-up Performance Across Demographic Groups (Age, Gender, Physical Activity Level, and Geographical Location)**

Demographics		n	M	SD	Min (kg)	Max (kg)	Range
Age	12	78	36.413	7.972	23.040	63.090	40.050
	13	249	38.261	8.669	16.930	65.500	48.570
	14	309	39.838	8.711	19.040	68.270	49.230
	15	275	39.626	8.707	17.050	68.850	51.800
	16	87	39.007	7.339	22.830	58.000	35.170
Gender	F	529	38.128	8.184	16.930	68.270	51.340
	M	469	40.082	8.888	19.040	68.850	49.810
Physical Activity Level	Active	496	38.809	8.749	16.930	68.270	51.340
	Highly Active	468	39.358	8.226	20.450	65.500	45.050
	Low Active	34	38.219	10.592	19.550	68.850	49.300
Geographical Location	Rural	597	38.679	9.247	16.930	68.850	51.920
	Urban	401	39.593	7.436	23.780	62.880	39.100
<b>Overall</b>		<b>998</b>	<b>39.046</b>	<b>8.574</b>	<b>16.930</b>	<b>68.850</b>	<b>51.920</b>

Note. n = sample size, M = mean, SD = standard deviation, Min = minimum, Max = maximum

Table 1 presents the descriptive profile of participants’ estimated one-repetition maximum (1RM) push-up performance across demographic categories, revealing that the total sample (N = 998) demonstrated an overall mean estimated 1RM of 39.05 kg (SD = 8.57), with scores ranging from 16.93 kg to 68.85 kg. This broad performance range indicates substantial variability in adolescent upper-body pushing strength, suggesting that while the sample generally exhibited measurable muscular strength, considerable inter-individual differences exist across developmental and contextual factors.

Across age groups, estimated mean 1RM values increased from age 12 (n = 78, M = 36.41 kg, SD = 7.97) to age 14 (n = 309, M = 39.84 kg, SD = 8.71), before stabilizing at ages 15 (n = 275, M = 39.63 kg, SD = 8.71) and 16

( $n = 87$ ,  $M = 39.01$  kg,  $SD = 7.34$ ), reflecting expected developmental improvements in muscular strength during adolescence. These findings suggest that upper-body strength generally progresses with maturation, though variability remains evident within each age category.

Gender comparisons showed that male participants ( $n = 469$ ,  $M = 40.08$  kg,  $SD = 8.89$ ) demonstrated slightly higher estimated 1RM push-up performance than female participants ( $n = 529$ ,  $M = 38.13$  kg,  $SD = 8.18$ ), indicating modest sex-related differences in upper-body strength while also highlighting broad performance overlap between groups.

In terms of physical activity level, active participants ( $n = 496$ ,  $M = 38.81$  kg,  $SD = 8.75$ ), highly active participants ( $n = 468$ ,  $M = 39.36$  kg,  $SD = 8.23$ ), and low active participants ( $n = 34$ ,  $M = 38.22$  kg,  $SD = 10.59$ ) demonstrated relatively similar mean scores, suggesting that general activity classification alone may not fully capture strength-specific adaptations.

Geographic location data further showed that urban participants ( $n = 401$ ,  $M = 39.59$  kg,  $SD = 7.44$ ) performed slightly better than rural participants ( $n = 597$ ,  $M = 38.68$  kg,  $SD = 9.25$ ), although both groups displayed wide score distributions. Overall, the descriptive findings indicate that estimated 1RM push-up performance among adolescents is shaped by age, gender, and geographic context, while substantial within-group variability underscores the importance of individualized and demographically contextualized strength interpretation.

Meanwhile, Table 2 presents the result of the inferential statistics to determine the differences in estimated 1RM push-up performance across group criteria.

**Table 2** Summary of Inferential Tests Examining Differences in Estimated 1RM Push-Up Performance Across Demographic Groups

Grouping Variable	Statistical Test	Test Statistic	p-value	Effect Size	Result
Age	One-way ANOVA	$F(4, 993) = 3.543$	.007	$\eta^2 = 0.014$	Significant
Gender	Independent t-test	$t(996) = -3.549$	< .001	$d = 0.23$	Significant
Geographic location	Welch's t-test	$t(967.655) = -2.296$	.022	$d = 0.15$	Significant
Physical activity level	One-way ANOVA	$F(2, 995) = 0.942$	.390	$\eta^2 = 0.002$	Not significant

Inferential analyses demonstrated that estimated 1RM push-up performance varied significantly across several demographic variables, although the magnitude of these differences was generally small. Specifically, age significantly influenced estimated 1RM push-up performance,  $F(4, 993) = 3.543$ ,  $p = .007$ ,  $\eta^2 = 0.014$ , indicating that participants' push-up strength differed across age categories. Post hoc findings showed that participants aged 14 and 15 significantly outperformed those aged 12, suggesting developmental improvements in upper-body strength during early adolescence. Therefore,  $H_01$  was rejected.

Similarly, gender significantly differentiated estimated 1RM push-up performance,  $t(996) = -3.549$ ,  $p < .001$ ,  $d = 0.23$ , with male participants demonstrating higher mean scores than female participants. Although the effect size was small, the difference was statistically meaningful, leading to the rejection of  $H_02$ .

Geographic location also produced a statistically significant difference,  $t(967.655) = -2.296$ ,  $p = .022$ ,  $d = 0.15$ , as urban participants slightly outperformed rural participants; thus,  $H_03$  was likewise rejected.

However, physical activity level did not significantly influence estimated 1RM push-up performance,  $F(2, 995) = 0.942$ ,  $p = .390$ ,  $\eta^2 = 0.002$ , indicating comparable performance regardless of activity classification. Consequently,  $H_04$  was accepted. Overall, these findings suggest that age, gender, and geographic location are statistically associated with differences in estimated upper-body strength performance, whereas self-reported physical activity level alone may not sufficiently distinguish push-up strength outcomes among participants.

Furthermore, Table 3 shows the percentile cut-offs as basis for classifying estimated 1RM push-up performance according to group.

**Table 3 Percentile Cut-offs (P20, P40, P60, P80) Used to Classify Estimated 1RM Push-Up Performance by Age Group, Gender, and Geographic Location**

Grouping Variable	Group (n)	P20	P40	P60	P80	Norm Classification Based on Cut-offs*
<b>Age group</b>	12–13 (327)	30.64	34.59	39.05	45.41	Poor $\leq 30.64$ ; Fair 30.65–34.59; Good 34.60–39.05; Very Good 39.06–45.41; Excellent $\geq 45.42$
	14–15 (584)	32.58	36.77	41.10	46.91	Poor $\leq 32.58$ ; Fair 32.59–36.77; Good 36.78–41.10; Very Good 41.11–46.91; Excellent $\geq 46.92$
<b>Gender</b>	Female (529)	31.46	35.52	39.38	45.75	Poor $\leq 31.46$ ; Fair 31.47–35.52; Good 35.53–39.38; Very Good 39.39–45.75; Excellent $\geq 45.76$
	Male (469)	32.53	36.99	41.70	47.23	Poor $\leq 32.53$ ; Fair 32.54–36.99; Good 37.00–41.70; Very Good 41.71–47.23; Excellent $\geq 47.24$
<b>Location</b>	Rural (597)	30.91	35.52	40.03	46.23	Poor $\leq 30.907$ ; Fair 30.908–35.519; Good 35.520–40.029; Very Good 40.030–46.229; Excellent $\geq 46.230$
	Urban (401)	32.99	37.42	41.18	46.35	Poor $\leq 32.989$ ; Fair 32.990–37.419; Good 37.420–41.179; Very Good 41.180–46.349; Excellent $\geq 46.350$

Norm development was based on untransformed estimated 1RM scores to preserve the interval nature of the measure and ensure interpretable percentile thresholds. Table 3 presents normative cut-offs for two developmental age bands (12–13 and 14–15 years). The P20, P40, P60, and P80 values were used to classify strength into five categories—Poor, Fair, Good, Very Good, and Excellent—consistent with percentile-based standards recommended for population-specific fitness interpretation (Rubín et al., 2023; Zhang et al., 2021). For ages 12–13, the thresholds increased from Poor ( $\leq 30.64$ ) to Excellent ( $\geq 45.42$ ), while for ages 14–15, the thresholds shifted upward (Poor  $\leq 32.58$ ; Excellent  $\geq 46.92$ ). The upward displacement of cut-offs in the older age band indicates that higher estimated 1RM values are required to achieve equivalent relative standing as adolescents progress through mid-adolescence.

## DISCUSSION

The findings showed that participants had measurable estimated 1RM push-up performance, with an overall mean of 39.05 kg and a wide range of scores. This indicates that upper-body pushing strength among the adolescents varied considerably, which is expected because strength performance during adolescence is influenced by growth, maturation, neuromuscular coordination, body composition, and movement experience. The pattern of increasing mean performance from age 12 to age 14, followed by relative stabilization at ages 15 and 16, supports previous literature indicating that muscular fitness develops progressively during adolescence as biological maturity and physical competence improve (Butulis et al., 2023; Cheng et al., 2023; Coogan et al., 2021; Mateo-Orcajada et al., 2024).

Age significantly differentiated estimated 1RM push-up performance, with participants aged 14 and 15 performing significantly better than those aged 12. Although the effect size was small, the result suggests that age remains an important consideration in interpreting adolescent strength outcomes. This finding is consistent with studies showing that adolescent fitness performance improves with age due to increases in muscle mass, coordination, and exposure to structured physical activity (Liao et al., 2021; Niessner et al., 2020). Since push-up performance also depends on cadence control, body alignment, and proper technique, older learners may have greater movement familiarity and physical readiness than younger participants (Baumgartner et al., 2002, 2004; Gomez, 2025).

Gender also produced a significant difference in estimated 1RM push-up performance, with males obtaining higher mean scores than females. This result supports previous evidence that males often demonstrate greater absolute upper-body strength due to differences in lean mass, hormonal influences, and neuromuscular development during adolescence (Bartolomei et al., 2021; Nuzzo & Pinto, 2025; Santtila et al., 2020). However, the small effect size indicates that the difference should not be overstated, as both male and female participants showed wide performance distributions. This suggests that strength outcomes are not determined by sex alone but are also shaped by training exposure, body composition, trunk stability, and lifestyle factors (Ben Mansour et al., 2021; Bennie et al., 2021; Kihoon et al., 2020).

Geographic location significantly differentiated estimated 1RM push-up performance, with urban participants showing slightly higher mean scores than rural participants. This finding suggests that environmental context may influence strength development through access to facilities, organized sports, structured exercise opportunities, and lifestyle patterns. Previous studies similarly note that urbanization, environmental access, and physical activity opportunities can shape fitness outcomes among young people (Al-Nuaim & Safi, 2022; Portela-Pino et al., 2021). Still, the small effect size indicates that geographic location has limited practical influence, and individual factors such as training experience, maturation, and activity specificity may be more important than residence alone (Bennie et al., 2021; Mateo-Orcajada et al., 2024).

In contrast, physical activity level did not significantly differentiate estimated 1RM push-up performance. This implies that broad self-reported activity categories may not be sensitive enough to capture strength-specific differences, particularly when activities vary in intensity, frequency, and muscular demand. General physical activity does not always translate into upper-body pushing strength unless it involves resistance-based or upper-body loading movements. Prior studies emphasize that strength performance is influenced not only by activity volume but also by exercise type, movement specificity, technical skill, and neuromuscular efficiency (Alekseyev et al., 2020; Dhote et al., 2024; Santos et al., 2023). Thus, adolescents classified as active or highly active may not necessarily perform better in push-ups if their activities do not specifically train the upper body.

The proposed percentile-based norms provide practical, context-specific reference standards for interpreting estimated 1RM push-up performance among adolescents. By developing norms according to age, gender, and geographic location, the study supports fairer and more developmentally appropriate strength assessment. This approach aligns with literature emphasizing that normative standards should be population-specific, demographically sensitive, and based on standardized procedures to improve interpretive accuracy (Lenhard et al., 2021; Rubín et al., 2023; Zhang et al., 2021). Overall, the findings support the usefulness of the Epley-based push-up test as a safe, practical, and school-relevant method for estimating upper-body strength, while reinforcing the need to interpret adolescent fitness performance through contextualized norms rather than universal cut-off scores (García-Suárez et al., 2022; Gomez, 2025; Tillaar & Ball, 2020).

### Limitations Of the Study

Several limitations should be considered when interpreting the findings of this study. First, the sample was drawn exclusively from public junior high schools in the Province of Bukidnon, which constrains the generalizability of the proposed normative standards to adolescents in other Philippine regions whose lifestyle, climate, school programming, and physical activity exposure may differ substantially. Although the stratified sampling approach captured variation across three districts within Bukidnon, the norms should be regarded as provincially specific reference values rather than national standards. Second, physical activity level was assessed through self-report and classified into three broad categories (low active, active, highly active). Self-reported activity measures are susceptible to recall and social-desirability biases, and the broad categories used here may not adequately capture the intensity, frequency, or movement specificity that drive upper-body strength adaptations. The non-significant difference observed across activity groups should therefore be interpreted cautiously, as it may partly reflect limitations of the classification instrument rather than a true absence of activity-related differences.

Third, body mass index (BMI) and other anthropometric variables were not included as covariates. Given that body composition is known to influence push-up performance, the absence of BMI control limits the extent to which the observed differences across demographic groups can be attributed to muscular strength alone rather than to differences in body composition. Fourth, the study employed a cross-sectional descriptive-comparative

design, which permits identification of group differences at a single point in time but precludes inferences about developmental trajectories or causal relationships. Longitudinal monitoring would be required to characterize how individual strength changes across adolescence. Fifth, although the inferential tests yielded statistically significant differences across age, gender, and geographic location, the corresponding effect sizes were small ( $\eta^2 \leq 0.014$ ; Cohen's  $d \leq 0.23$ ). Statistically significant differences with small effect sizes should be interpreted with restraint, particularly when translating findings into practical or policy recommendations.

Sixth, group sizes were uneven across categories, most notably for the Low Active group ( $n = 34$ ) relative to the Active ( $n = 496$ ) and Highly Active ( $n = 468$ ) groups. Such imbalance reduces statistical power for between-group comparisons involving the Low Active subgroup and may inflate variability in its descriptive estimates. Seventh, the proposed normative bands cover ages 12–13 and 14–15 only; participants aged 16 ( $n = 87$ ), although included in the descriptive analyses, were not represented in the norm tables because of the smaller cell size. As a result, the norms should not be extended to 16-year-olds or older students without further validation. Finally, while the use of submaximal estimation through the Epley formula offered safety and practical advantages over direct 1RM testing, the resulting values are estimates rather than direct measures of maximal strength. Although the validity of the Epley-based push-up has been previously established (Gomez, 2025), additional concurrent-validity studies against laboratory-based strength measures would strengthen confidence in the absolute values reported here.

## CONCLUSION

This study established population-specific normative standards for assessing upper-body strength using an estimated one-repetition maximum (1RM) push-up test based on the Epley formula among high school students in Bukidnon. The findings indicate that adolescents demonstrate measurable and widely distributed push-up-based strength, with significant differences observed across age, gender, and geographic location, reflecting developmental, physiological, and contextual influences on muscular performance. Age-related improvements aligned with expected maturation patterns, while gender-based differences were consistent with established variations in upper-body strength and neuromuscular development. Although geographic location showed only small effects, the results highlight the relevance of environmental context in interpreting strength outcomes. In contrast, physical activity level did not significantly differentiate estimated 1RM push-up performance, suggesting that general activity classification alone may not adequately capture upper-body strength capacity under standardized testing conditions.

Based on these findings, percentile-based norms were developed using untransformed estimated 1RM scores, yielding practical classifications of Poor, Fair, Good, Very Good, and Excellent performance. The proposed age-, gender-, and locale-specific norms provide a fair, interpretable, and context-sensitive framework for evaluating adolescent upper-body strength in school-based physical education. By integrating a validated submaximal strength estimation approach with a standardized push-up protocol, this study offers a safer and more informative alternative to repetition-only assessment methods. These normative standards can support fitness screening, progress monitoring, and evidence-based program planning, while contributing to the broader literature on localized and developmentally appropriate strength assessment in adolescent populations.

## RECOMMENDATIONS

In light of the findings and the limitations identified, the following recommendations are advanced.

For physical education practice, teachers and sports coordinators are encouraged to adopt the proposed age-, gender-, and locale-specific estimated 1RM push-up norms when interpreting student performance, in preference to generalized repetition-based reference values. Use of population-specific norms supports fairer classification, reduces the likelihood of misjudging adolescent capacity based on inappropriate benchmarks, and provides a defensible basis for individualized goal-setting and progress monitoring. Teachers should also be oriented on the standardized push-up protocol (cadence control, body alignment, and form criteria) used to derive the norms, so that classroom assessments produce results comparable to the reference distributions reported here.

For school administrators and the Department of Education, the findings support the integration of the Epley-based push-up protocol into existing school fitness assessment routines as a safer and more interpretable alternative to repetition-only scoring. School heads are encouraged to support the training of physical education teachers in the cadence-controlled protocol and the use of percentile-based classifications, and to incorporate the norms into the DepEd Physical Fitness Test interpretive framework where compatible. Investment in basic measurement tools (digital weighing scales, audio metronomes) is modest and would substantially improve the consistency of strength assessment across schools in the province.

For policy, the small but statistically significant urban–rural difference observed in this study suggests that programmatic attention should be directed toward strengthening upper-body conditioning opportunities in rural school settings, including the provision of equipment-light resistance activities and structured intramural programming. The non-significant finding for physical activity level further suggests that general activity promotion campaigns may need to be paired with explicit upper-body strength components if measurable gains in muscular strength are a desired outcome.

For future research, three lines of inquiry are recommended. First, the norming exercise should be extended to additional Philippine provinces and to a broader age range (including 11-year-olds and senior high school students aged 16–18) to support the development of regional and eventually national norms. Second, future studies should incorporate objective measures of physical activity (such as accelerometry or validated questionnaires like the PAQ-A) and anthropometric covariates including BMI, fat-free mass, and limb length, so that the contribution of body composition to push-up performance can be partitioned from that of muscular strength itself. Third, longitudinal designs are needed to characterize how estimated 1RM push-up performance evolves across the adolescent years and how it responds to structured PE interventions; such designs would also permit the construction of growth-referenced rather than purely cross-sectional norms. Finally, concurrent-validity studies comparing the Epley-based estimated 1RM with laboratory-based measures of upper-body strength would further strengthen the interpretive value of the protocol in school-based contexts.

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## Conflict Of Interest

The authors declare no conflict of interest in the conduct, analysis, or reporting of this study.

## Author Contributions

J.B. conceptualized the study, conducted data collection, and drafted the manuscript. O.N.G. supervised the research, provided methodological guidance, contributed to the development of the testing protocol, and critically revised the manuscript. Both authors read and approved the final version of the manuscript.

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