

Understanding endurance running performance in Japanese high school KOSEN students: Psychometric Approach

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Abstract

Background. Endurance running, commonly included physical education (PE) classes in Japanese high schools, has been unpopular. Partly, it is an individually oriented sport that tends to push students to run at full speed, resulting in a state of "mental isolation." Non-athletic students, in particular, are discouraged as they are more likely to feel pressured to match the pace of their athletic peers during endurance running. In this study, endurance running performance of Japanese high school students including both athletes and non-athletes was evaluated using psychometric surveys. **Materials & Methods.** A total of 45 male high school students (Height: 169.7 ± 5.0 cm; Weight: 59.2 ± 9.9 kg) participated in outdoor running tests during their PE classes. Prior to running, students took two psychometric surveys with a question about motivation toward running: Ten Item Personality Inventory (TIPI-J) which measures the Big Five dimensions (extraversion/introversion, agreeableness, conscientiousness, emotional stability, and openness) and Short Grit (Grit-S) which measures perseverance and passion. The students ran a 1500 m on a track, and their finishing times were recorded. Finishing times, motivation, and each psychometric survey were analyzed using multiple linear regression (MLR) analyses. **Results.** The TIPI-J results indicated that those who had faster running times tended to have more conscientiousness ($p = 0.02$) extraversion ($p = 0.02$), and less openness ($p = 0.02$) ($F [5, 39] = 4.57$, $p < 0.001$, $R^2 = 0.37$). The Grit-S results showed faster finish times were statistically associated with greater perseverance ($p = 0.001$) ($F [2, 42] = 5.86$, $p = 0.006$, $R^2 = 0.22$). Motivation was also significantly associated with running time ($p = 0.01$) ($F [1, 43] = 12.33$, $p = 0.001$, $R^2 = 0.22$). **Conclusions.** Motivation, perseverance, conscientiousness, and extraversion led to more positive running performance. Using these findings based on psychometric surveys, teachers can encourage those who dislike endurance running to run better by emphasizing the need to keep practicing and improving their performance, rather than finish times, until they have become more comfortable, confident and motivated.

Keywords: non-athletic students, physical education, TIPI-J, Grit-S, motivation, running strategies

Introduction

The endurance running is a common fitness test used in physical education (PE) classes in Japanese elementary, middle and high schools. Typically, high school students are required to run up to 1500 m for boys and 1000 m for girls within a limited time. The purpose of endurance running is for students to learn their own pace to finish within a certain time and measure their aerobic endurance levels. This requirement was introduced in 1949 and remains in place today (Suzuki et al., 2016).

However, compared to other PE sports like group activities, endurance running has been an unpopular among Japanese students (Matsumoto et al., 2025). Partially, endurance running is an individually oriented sport that directly affects performance of students, resulting in "mental isolation" unlike team sports. In addition, Japanese students put themselves under peer pressure, push themselves too hard, tend to run at full speed by competing with other students, and exhaust themselves by the time they finish. Because of these reasons, many Japanese students have labeled endurance running as "extremely tough" and "exhausting" sports. Furthermore, the fitness levels of Japanese students have been decreasing over the years due to more sedentary lifestyles, attributed, in part, to the usage of smart phones and COVID-19 behavioral restrictions (Statistics Bureau of Japan, 2025).

Despite the unpopularity of endurance running due to the mental and physical burden on students, the Ministry of Education in Japan has been promoting a shift away from result-oriented education. However, a substantial number of Japanese schools still follow the traditional Japanese PE curriculum, continuing to emphasize competition, the attainment of advised physical performance goals, and result-oriented instruction. This tendency is partly due to the national curriculum standards, which have consistently measured students' performance in a uniform manner over time, enabling the monitoring of both longitudinal and cross-sectional changes while also defining instructional content and teaching objectives designed to improve performance (Ministry of Education, Culture, Sports, Science & Technology, 2022). Compared to physical education programs in Europe and the United States, which often emphasize the development of children's personalities

and the intrinsic enjoyment of sport (Tomimoto, 2013), the students' negative attitudes toward endurance running are not readily incorporated into PE practices at the school level in Japan. Consequently, these contextual factors—including the unpopularity of endurance running, prevailing behavioral patterns and lifestyle choices among Japanese high school students, and the existing structure of the PE curriculum—appear to reinforce a negative cycle characterized by declining sports performance, reduced motivation for endurance running, and poorer running outcomes.

In recent years, researchers have examined the personalities/mind-set of athletes using psychometric tests to improve their performance and technical tactics (Braschler et al., 2024; Hori et al., 2019; Hsieh et al., 2025; Lochbaum et al., 2022; Nishiyama et al., 2020; Piepiora et al., 2019; Reyes-Bossio et al., 2022; Roebuck et al., 2020; Shuai et al., 2023). According to the extensive meta-analyses, neuroticism, openness, conscientiousness, extraversion and agreeableness are overall positively associated with general sports performance (Shuai et al., 2023). However, characteristics for better performance vary by types of sports and are still inconclusive in some sports. Group sports such as basketball, volleyball, and soccer require more cooperation, and openness for better performance (Shuai et al., 2023), while individual sports like marathon running tend to show more vigor and emotionally controllable characteristics (Braschler et al., 2024). In particular, the association between personality traits and performance have shown different results across running studies: Marathon runners were generally described as more reserved and introverted (Roebuck et al., 2020), whereas other studies reported that endurance runners that race fewer miles than marathon runners tended to show higher levels of extraversion, openness (i.e. willingness to learning from their experiences), and conscientiousness (Piepiora et al., 2019). Furthermore, anxiety levels of runners were demonstrated to differ significantly between performance levels: higher-level runners exhibited lower anxiety, while neuroticism and openness were traits that contributed significantly to anxiety among middle- and lower-level runners (Hori et al., 2019).

However, these psychometric studies were primarily focused on professional or competitive runners. Very limited attention was given to school environment, such as PE classes where both athletes and non-athletes engage in the same sporting activities. Although PE instructors encourage students to run at their own pace during endurance running, PE classes consisting of both athletic and non-athletic students tend to maintain "a uniform atmosphere" in which non-athletic students are likely to be pressured to keep up with athletic students. Consequently, these non-athletic students may overexert themselves, which can trigger negative cycles of increased psychological burdens and physical strains, leading to increased dislike and poorer performance in endurance running. Under the Japanese PE curriculum where improving physical fitness is important for all students, providing psychometric surveys for non-athletes is equally important to find out their "true" personality traits such as anxiety, motivation, openness, extraversion and perseverance. In this way, we have a better understanding of why non-athletes perform differently from athletes, identify what personality traits are likely to be associated with better running performance, and more importantly, understand how PE teachers can strategically support these students to enhance their performance.

In this study, we introduce psychometric surveys to the National Institute of Technology (NIT) - KOSEN students in endurance running tests during their PE classes. The KOSEN, the unique Japanese educational institution combining high school and college systems, focuses studies on science and engineering at the early age of 15 years. Given its specialized focus on science and engineering disciplines, the KOSEN academic curricula tend to deemphasize liberal arts classes including physical education, resulting in a reduced hours in structured PE sports and extracurricular sports activities relative to those in standard high schools (Ministry of Education, Culture, Sports, Science & Technology, 2022; National Institute of Technology (KOSEN), Hachinohe College, 2025). As a result, KOSEN students tend to show lower average performance scores in physical education compared to students attending traditional high schools (Kadata & Ikehara, 2016; Ministry of Education, Culture, Sports, Science & Technology, 2022; Yokota & Kawabata, 2024). Focusing on this population provides a valuable opportunity to examine more clearly the association between personality traits—particularly among non-athletic students—and endurance running performance, as their athletic experiences are often more limited and less influenced by intensive sports training. Ultimately, the application of psychometric surveys in PE contexts may offer important insights for both educators and policymakers by highlighting individual differences in personality and performance. Such efforts in this study can further contribute to reconsidering the "one-size-fits-all" approach to endurance running in Japanese PE classes, promoting more inclusive and individualized instructional strategies that better accommodate diverse student backgrounds and abilities.

Materials & Methods

A total of 45 male high school students (Age: 16 ± 0.7 yrs; Height: 169.7 ± 5.0 cm; Weight: 59.2 ± 9.9 kg; BMI: 20.5 ± 3.2 kg/m²) participated in outdoor ER tests during their PE classes in summer when it was safe to exercise based on a heat stress safety guideline (Ministry of Education, Culture, Sports, Science & Technology, 2022). This study was approved by the Ethics Committee of NIT (KOSEN) Hachinohe College. Prior to the study participation, the students and their parents gave their written informed consent. The consent form included the purpose, risks, and importance of the study. Volunteers were able to withdraw at any time if they wished.

On test days, the students' heights and weights were measured. Students then took two psychometric surveys in addition to a question about motivation toward endurance running: Ten Item Personality Inventory (TIPI-J) which is a 10-item measure of the Big Five dimensions (extraversion/introversion, agreeableness, conscientiousness, emotional stability, openness to experience) and Short Grit (Grit-S) which measures perseverance and passion for long term goals. The details of the survey were described elsewhere (Duckworth & Quinn, 2009; Gosling et al., 2003; Nishikawa et al., 2015; Oshio et al., 2012). We used the Japanese versions of TIPI-J and Grit-S as psychometric instruments because the brevity and ease of implementation within the constraints of PE class settings. In addition, the surveys are simple and easy for high school students to understand and answer the questions. Both psychometric instruments have been previously validated in Japanese, ensuring their reliability and appropriateness for this context (Nishikawa et al., 2015; Oshio et al., 2012). To assess students' intrinsic motivation toward endurance running, a single-item measure was also incorporated into the psychometric survey. The initial five-category motivation scale (1 = very much, 2 = somewhat, 3 = normal, 4 = less, 5 = not at all) was classified into a binary variable. Scores of 1–3 were coded as 1 (yes), and scores of 4–5 were coded as 0 (no). After they took these surveys, students ran a 1500 m time trial on a track, and their finish times were recorded.

Finishing times, psychometric traits and motivation toward endurance running tests were analyzed using multiple linear regression (MLR) analyses.

Results

1500 m endurance running time

The mean and standard deviation of running time of KOSEN high school runners in this study were 436.2 ± 68.1 seconds (7.3 ± 1.1 minutes), which was statistically slower than the national average time of high school male students in Japan (369 ± 52.7 seconds for the first-year high school, 371 ± 52.7 seconds for the second-year high school) (Statistics Bureau of Japan, 2025) ($p < 0.05$).

Running Performance and TIPI-J

Table 1 shows the association between running performance and TIPI-J using MLR analysis. The traits such as extraversion, conscientiousness and openness to experience are significantly associated with finishing times ($p < 0.05$) ($F [5,39] = 4.57$, $p = 0.002$, $R^2 = 0.37$). Figure 1 shows the comparisons by running performance groups in each psychometric trait. Finishing times were classified into three groups by percentiles: fast (33 percentile, < 404 seconds), medium ($405 \sim 446$ seconds), and slow (66 percentile, > 447 seconds) to examine if trends in each psychometric trait were different by running groups. The fast-running group demonstrated statistically significantly higher traits of extraversion and conscientiousness relative to other groups. In contrast, slow runners tended to show a greater tendency toward openness.

Table 1 Multiple linear regression results in Ten Item Personality Inventory (TIPI-J).

Running Time	Coefficient	Standard Error	T	P > t
Extraversion*	-8.74	3.47	- 2.52	0.02
Agreeableness	0.90	4.63	0.20	0.85
Conscientiousness*	-9.70	4.14	- 2.34	0.02
Emotional Stability	-1.63	4.40	- 0.37	0.71
Openness*	12.17	4.80	2.54	0.02
Constant	463.45	64.64	7.17	0.00

*significantly different at $p < 0.05$

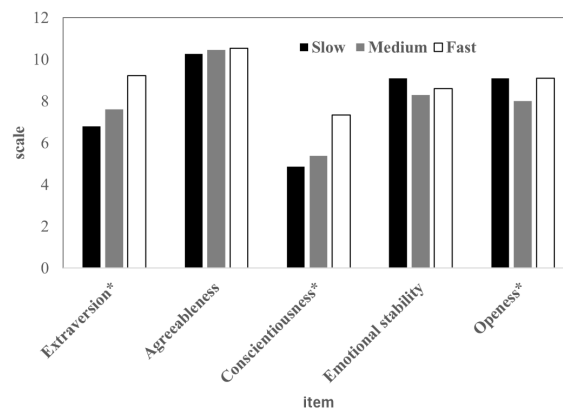


Figure 1. The psychometric trait comparisons by running groups in Ten Item Personality Inventory (TIPI-J). (*indicates statistically significant differences between groups)

Running Performance and Grit-S

Table 2 shows the summary of the relationship between running performance and psychometric trait in Grit-S. The finish times were statistically significant for perseverance ($p = 0.001$) ($F [2,42] = 5.86$, $p = 0.006$, $R^2 = 0.22$). Figure 2 shows the comparisons by running performance groups in each psychometric trait of Grit-S. The individuals classified into the fast-running group indicated higher perseverance scores than the counterparts in the medium and slow groups.

Table 2 Multiple linear regression results in Short Grit (Grit-S).

Running time (seconds)	Coefficient	Standard Error	T	P > t
Perseverance*	-10.21	2.99	-3.41	0.001
Passion	3.56	3.18	1.10	0.280
Constant	522.48	42.70	12.23	0.000

*significantly different at $p < 0.05$

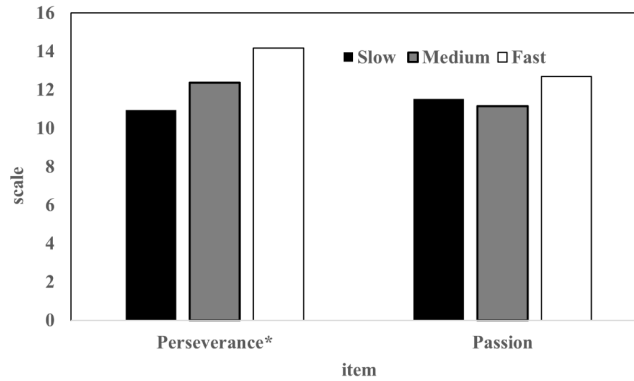


Figure 2. The psychometric trait comparisons among running performance groups in Short Grit (Grit-S). (*indicates statistically significant differences between groups)

Running performance and Motivation

The students who answered that they had a motivation for endurance running was 40% (18/45) while the remaining 60% (27/45) answered less, or no motivation.

Table 3 shows the summary of the relationship between running performance and motivation. The finish times were statistically associated with motivation ($p = 0.001$) ($F [1,43] = 12.33$, $p = 0.001$, $R^2 = 0.22$). Figure 3 shows the comparisons of motivation by running performance groups. Clearly, the fast-running group showed higher motivation than the other groups, and most of the slow-runners answered no motivation for endurance-running.

Table 3 Multiple linear regression results in Motivation survey.

Running time (seconds)	Coefficient	Standard Error	T	P > t
Motivation* (0: no, 1: yes)	-64.85	18.47	-3.51	0.001
Constant	462.19	11.68	39.57	0.000

*significantly different at $p < 0.05$

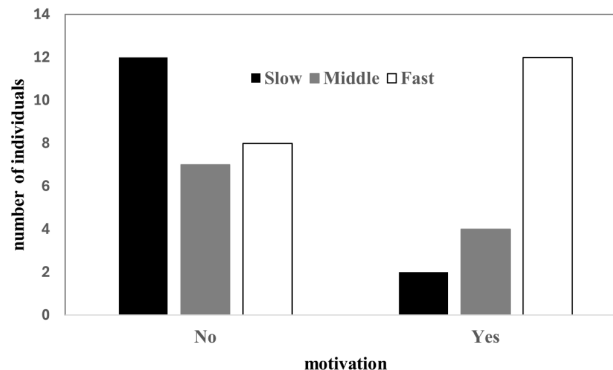


Figure 3. Motivation levels by running performance groups.

Discussion

Like other studies (Kadata & Ikehara 2016, Statistics Bureau of Japan 2025), this study also showed that the average running time in KOSEN students was statistically lower than national average time of high school students. Based on activity data from the Australian Institute of Health & Welfare (2023) as a reference, approximately 60% of the participants in this study were identified as having a low physical activity level, defined as engaging in less than 600 MET minutes per week. Meanwhile, 27% of the students were classified as moderately active, and only 13% as highly active. The runners in this study were the first-year students, "COVID-Generation" who went through long behavioral restrictions during the pandemic and tended to spend few hours in sports activities while attending KOSEN. In addition, the first-year students spent many hours preparing for the high school entrance exams, diminishing exercise hours and physical strength when they enrolled in high school. All these factors may explain overall poor performance time observed in this study.

Although previous studies have shown varying relationships between athletes' personalities and their performance using psychometric surveys (Hsieh et al., 2025; Piepiora et al., 2019; Roebuck et al., 2020), this study focused on high school KOSEN students with both athletic and non-athletic backgrounds. The results indicated that motivation, perseverance, conscientiousness, and extraversion were positively associated with endurance running performance, while openness showed a negative correlation with running performance. Compared to other high school sports studies, Takano et al. (2022) similarly found that sports performance among KOSEN students was strongly linked to perseverance rather than passion, as measured by the Grit-S scale, which is consistent with the present study. Similarly, a strong association between running performance and conscientiousness was previously reported among high school students (Gao et al., 2024). Furthermore, Hori et al., (2019) suggested that lower-level runners tend to exhibit higher levels of openness, which may increase trait anxiety. This observation aligns with the current findings, where openness was notably characteristic of slower runners. Openness, often associated with curiosity, creativity, and a tendency to diverge from routine activities, is commonly observed among KOSEN students, including those from non-athletic backgrounds, as they are frequently engaged in creative research activities in science and engineering.

For improvement with practice and experience, other non-cognitive skills such as extraversion, perseverance, conscientiousness, and motivation that were significantly distinct by running performance in this study, can be potentially transformed over periods of time. Unlike cognitive skills such as memory tasking and paper exams, which tend to reach plateau by late adolescence, non-cognitive skills are relatively malleable. Natsuhara and Kato (2017) studied effects of sports experiences on non-cognitive skills including motivation, resilience, endurance, self-control, self-efficacy to achieve goals, and metacognitive ability to analyze one's thoughts and learning process of school children. Their findings indicated that non-cognitive skills were higher in children who are more engaged in sports activities than those spending less time on sports activities. Through their sports activities, children were able to obtain skills to overcome discomfort, adapt to setbacks, tackle and resolve problems and find solutions, although the time required may vary by individuals (Natsuhara & Kato, 2017). Because non-cognitive traits become especially relevant for sports, endurance running which demands sustained effort, mental toughness, and self-regulation, are not innate but can be nurtured.

Alternatively, as suggested by Sasayama et al. (2017), implementing slow jogging exercises at a moderate intensity (heart rate of 120-140 beats per minutes; Rating of Perceived Exertion 11-13) can effectively bridge the gap between physical fitness levels and psychological engagement. Their study demonstrated that even students with lower physical fitness exhibited improved positive attitudes and reduced negative feelings toward endurance running after participating in a slow jogging exercise. Furthermore, the immediate post-exercise benefits, such as enhanced mood states and cognitive performance (e.g., calculation tasks), suggest that endurance running can be reframed as a tool for mental refreshment rather than a purely physical burden (Sasayama et al., 2017).

Case studies in Japanese high schools provide concrete evidence for the efficacy of this reframing (Hijikata 2014; Sato et al., 2025). Hijikata (2014) implemented a program called "Keep Moving Forward for 30 Minutes!", which shifted the pedagogical focus from running speed to exercise duration. By showing marathon footage to reshape the activity's image and allowing students to maintain a conversational running pace, the program successfully mitigated the psychological resistance and "mental isolation" associated with traditional time trials. Additionally, the integration of creative technologies, such as "GPS drawing" to visualize movement paths as temporary artwork, offers an alternative framework for students to interact with their environment and evaluate the meaning of physical effort (Sato et al., 2025). These strategies—prioritizing psychological comfort, self-pacing, and creative engagement—serve as evidence-based motivational interventions that can foster long-term engagement and potentially enhance performance in endurance running.

In the context of endurance running in physical education classes, understanding students' psychological traits—such as motivation, extraversion, conscientiousness, and perseverance—can significantly enhance both teaching effectiveness and student outcomes. Thus, students, who become more self-aware of their strengths and weaknesses through psychometric feedback, are better equipped to set realistic goals, manage performance anxiety, and stay engaged in physical activities. At the same time, physical education teachers can use students' personality trait data to tailor instruction, create compatible groups, and adjust exercise menus by different physical activity and intensity levels to suit individual (or group) needs. For example, students who are less

confident or dislike running can be encouraged through small steps of process-oriented goals rather than sole performance metrics. By shifting the focus from finish times to personal improvement or achievement, teachers foster a growth mindset, helping students become more motivated, confident, and comfortable with physical challenges.

Finally, psychometric surveys have been commonly used in school environments to assess students' personal trait assessment, and their academic performance particularly pertaining to cognitive skills in language, mathematics and science (Phyllis et al., 2016; Svraka et al., 2024). The psychometric tools offer evidence-based insights that support student development, instructional planning, and school-wide decision-making. Besides, psychometry in physical education also can play a unique role by bridging the gap between cognitive and non-cognitive domains. Traits such as resilience, teamwork, and stress tolerance not only affect performance in physical tasks but also mirror behaviors that are essential for academic success. Moreover, integrating psychometric data into curriculum design allows for extensive personalized learning pathways, where instruction is tailored to the psychological profiles of learners. By understanding the collective traits and needs of student cohorts, schools can endorse physical education curricula that are physically beneficial as well as psychologically enriching—promoting lifelong engagement in physical activity and well-being as the goal. In this way, psychometric assessments can inform holistic educational strategies that support both physical and intellectual development.

Conclusions

The endurance running test, commonly incorporated into PE classes in Japanese schools for long time, has become very unpopular among Japanese students over the years. During endurance running tests, both athletic and non-athletic students put themselves under peer pressure, tend to run at full speed by competing with other students, and exhaust themselves by the time they finish. Although the Ministry of Education in Japan has been encouraging a shift away from result-oriented education, many schools still tend to follow the traditional PE curriculum, which is typically characterized by a competitive atmosphere, expected levels of physical performance, and an emphasis on outcomes. In PE classes where both athletic and non-athletic students perform endurance running together, non-athletic students are likely to be pressured to match the pace of their athletic peers. As a result, these non-athletes are more likely to experience psychological and physical strain, which may lead to increased dislike, reduced motivation, and lower performance in endurance running. In recent years, the use of psychometric tests to analyze personality for improving sports performance and technical tactics have become increasingly popular. However, most of these psychometric studies mainly focused on professional athletes or competitive runners, and few studies were conducted on the effects of psychometric traits on non-athletic runners. To address the above concerns described above particularly for non-athletes, this study examined the running performance and personality traits of the high school KOSEN students. Among KOSEN students, whose education predominantly focuses on engineering and provides limited opportunities for physical activities, marked differences in sports performance would be expected between athletes and non-athletes.

The results revealed endurance running performance was strongly dependent on both traditional physical efforts and students' personality traits, such as motivation, perseverance, conscientiousness, and extraversion. While openness, which linked to curiosity and creativity, has been reported to improve performance in athletes in previous studies, the present findings among KOSEN students were not evident. This suggests that creative research in science and engineering is expected of all KOSEN students, irrespective of whether they have an athletic background.

Although the Japanese physical education curriculum and guidelines for PE teachers remain the same, this study employs a theoretical and practical framework aimed at modifying instructions within PE contexts: it emphasizes the importance of introducing "a personalized instructional approach," based on students' psychological characteristics, into existing exercise activities rather than solely relying on uniform teaching standards. Specifically, by adjusting the difficulty of goal setting and the quality of feedback in accordance with students' levels of conscientiousness and personality traits, it is possible to reduce feelings of psychological isolation while maximizing performance and learning motivation.

The psychological findings obtained in this study provide a new framework for establishing effective physical education practices. Future research should focus on implementing intervention programs based on these psychological characteristics and conducting long-term verification of their effectiveness. This is expected to facilitate the establishment of a new model of endurance running instruction that integrates psychological knowledge, not only in KOSEN institutions but also in broader educational settings.

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