

Fitness Wearables and Autonomous Exercise Motivation Among College Students: A Quantitative Study Using the BREQ-3

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Abstract—Physical inactivity among college students is a persistent public health challenge. Fitness wearables are widely marketed as tools to promote active behaviour, yet statistical evidence on their association with the quality of exercise motivation remains limited. This study examines whether the use of fitness wearables is associated with higher autonomous exercise motivation among college students, using the Behavioural Regulation in Exercise Questionnaire-3 (BREQ-3). A cross-sectional survey of 176 college students (Mean age = 20.63 years, SD =2.72; 51.7% female) yielded 43 wearable users and 133 non-users. BREQ-3 subscale scores were computed for intrinsic, identified, introjected, external regulation, and amotivation, and a Relative Autonomy Index (RAI) was derived. Cronbach's alpha values exceeded 0.90 for all multi-item subscales. Shapiro-Wilk tests confirmed non-normal distributions, warranting Mann-Whitney U tests for group comparisons. Results indicated no statistically significant difference in overall RAI between wearable users (Mdn = 21.75) and non-users (Mdn = 18.00; $U = 4336.0$, $p = .179$). However, wearable users scored significantly higher on the introjected regulation subscale ($U = 4972.5$, $p < .001$), suggesting that wearables may be linked to ego-involved rather than purely autonomous motivation. These findings contribute to the Self-Determination Theory literature and highlight the need for app-design strategies that foster internalised, autonomous motivation rather than guilt-driven engagement.

Index Terms—fitness wearables, exercise motivation, Self-Determination Theory, BREQ-3, Relative Autonomy Index, college students

I. INTRODUCTION

Physical inactivity is one of the foremost public health concerns of the twenty-first century (World Health Organization, 2022). Among college and university student populations, the transition from school-based structured physical education to largely self-directed lifestyles frequently trigger a sharp decline in exercise engagement (Keating et al., 2005). This demographic is particularly important to study: exercise habits formed during young adulthood tend to persist into later life, carrying long-term implications for cardiovascular health, mental well-being, and academic performance (Sallis et al., 2000). Against this backdrop, consumer fitness wearables including smartwatches, activity trackers, and heart-rate monitors have proliferated rapidly. Devices such as the Apple Watch, Fitbit, and Samsung Galaxy Watch generate real-time biometric feedback, set step-count goals, and deliver motivational nudges. The global wearable technology market surpassed US\$95 billion in 2023 and is projected to continue growing (Statista, 2024). Proponents argue that wearables make physical activity more visible and thereby encourage greater engagement; critics caution that external feedback mechanisms may undermine intrinsic motivation once novelty fades (Lyons et al., 2014).

The motivational consequences of wearable use are best examined through the lens of Self-Determination Theory (SDT; Deci & Ryan, 1985, 2000). SDT distinguishes between autonomous motivation driven by genuine enjoyment or personally valued goals and controlled motivation, which is propelled by external rewards or internal pressures such as guilt.

Autonomous motivation predicts more sustained exercise behaviour, whereas controlled motivation is associated with fragile adherence and potential burnout (Teixeira et al., 2012). Despite the theoretical relevance of SDT to wearable use, few studies have rigorously compared the full BREQ-3 motivation profile of wearable users against non-users in a college sample. This study addresses that gap.

Research Aim: To examine whether the use of fitness wearables are associated with higher levels of autonomous exercise motivation among college students, operationalised through the BREQ-3 [9], [10] and its derivative Relative Autonomy Index (RAI).

A. Objectives

The study pursues four objectives:

- O1. Measure and compare BREQ-3 subscale scores between wearable users and non-users.
- O2. Calculate the RAI for each group and determine whether the difference is statistically significant.
- O3. Describe demographic and wearable-use characteristics of the sample.
- O4. Provide preliminary quantitative evidence to inform future longitudinal research.

II. LITERATURE REVIEW

2.1 Physical Inactivity Among College Students

Research consistently documents that physical activity declines during the college years. Keating et al. (2005) found that only 40–50% of US college students meet recommended physical activity guidelines. Similar patterns have been observed in university student cohorts across 22 countries (Peltzer et al., 2014), suggesting this is a global, rather than culturally specific, challenge. Barriers include academic workload, limited access to facilities, and loss of peer-exercise networks.

2.2 Fitness Wearables as Behavioural Intervention Tools

Wearable activity trackers leverage behavioural change techniques such as goal-setting, self-monitoring, and feedback loops. Systematic reviews (Bravata et al., 2007; Lyons et al., 2014) indicate that step-counting devices increase daily step counts by an average of approximately 2,000 steps. However, these effects are often short-lived, with adherence declining

after 6–12 weeks (Lyons et al., 2014). The mechanism driving these changes, whether intrinsic motivation, external accountability, or habit, remains poorly understood.

2.3 Self-Determination Theory and Exercise Motivation

Self-Determination Theory (Deci & Ryan, 1985, 2000) conceptualises motivation along a continuum from amotivation (absence of intention) through external regulation (compliance with external demands) and introjected regulation (internally pressured, guilt- or pride-driven) to identified regulation (personally valued) and intrinsic motivation (inherently enjoyable). Higher-quality, more autonomous motivation is robustly associated with sustained physical activity (Teixeira et al., 2012; Wilson et al., 2006). The Behavioural Regulation in Exercise Questionnaire (BREQ; Mullan et al., 1997), now in its third iteration (BREQ-3; Markland & Tobin, 2004; Wilson et al., 2006), is the most widely used instrument for assessing SDT-based motivation in exercise contexts. The BREQ-3 also enables computation of the Relative Autonomy Index (RAI), a weighted composite that places individuals on the autonomous-controlled continuum.

2.4 Wearables and Motivation Quality: The Research Gap

Studies examining the intersection of wearables and motivation quality are sparse. Shin & Biocca (2017) found that rich biometric dashboards could enhance a sense of competence, a basic psychological need in SDT. Conversely, Etkin (2016) demonstrated experimentally that tracking an inherently enjoyable activity reduced subsequent intrinsic motivation, a potential undermining effect. These conflicting findings call for direct measurement of the BREQ-3 profile across wearable user groups. The present study addresses this call.

III. THEORETICAL FRAMEWORK

This study is grounded in Self-Determination Theory (SDT; Deci & Ryan, 1985, 2000), one of the most empirically supported macro-theories of human motivation. SDT posits that optimal motivation and well-being arise when three basic psychological needs are satisfied: autonomy (sense of volition),

competence (sense of effectiveness), and relatedness (sense of connection with others). Within the domain of physical activity, SDT predicts that social environments and technologies that support need satisfaction will promote internalised, autonomous forms of exercise motivation, which in turn predict greater exercise adherence, positive affect, and long-term well-being (Deci & Ryan, 2000; Teixeira et al., 2012). Conversely, environments that are perceived as controlling, characterised by external pressure, surveillance, or contingent rewards, tend to undermine intrinsic motivation and produce controlled regulation patterns.

Fitness wearables occupy an ambiguous position within this framework. On the positive side, they can enhance perceived competence through real-time performance feedback, and structured goal-achievement may foster autonomy if users internalise goals as their own (Shin & Biocca, 2017). On the negative side, step-count competitions, achievement badges, and reminders to “close the ring” may function as external pressures, fostering introjected or external regulation (Etkin, 2016). The SDT framework therefore generates competing predictions that only direct empirical measurement can resolve.

The RAI operationalises an individual’s position on the autonomous-controlled continuum, assigning weights of +3 to intrinsic motivation, +2 to identified regulation, +1 to introjected regulation, -1 to external regulation, and -2 to amotivation. Higher RAI scores indicate more autonomous motivational profiles. The RAI has been validated in exercise contexts and shown to predict exercise behaviour beyond individual subscale scores (Mullan et al., 1997).

IV. CONSTRUCTS AND ITEMS USED

The primary measurement instrument used in this study was the Behavioural Regulation in Exercise Questionnaire-3 (BREQ-3; Markland & Tobin, 2004; Wilson et al., 2006), which assesses six dimensions of exercise motivation. The survey instrument included 20 items capturing the following constructs: intrinsic motivation, identified regulation, introjected regulation, external regulation, and amotivation. Subscale scores were calculated as the mean of their respective items as summarised in Table 1.

The Relative Autonomy Index (RAI) was computed using the standard weighting formula: $RAI = (3 \times$

$Intrinsic) + (2 \times Identified) + (1 \times Introjected) + (-1 \times External) + (-2 \times Amotivation)$, as proposed by Mullan et al. (1997), with higher scores indicating more autonomous motivation and lower scores reflecting more controlled or a motivated regulation. In addition, demographic and behavioural covariates collected included age, gender, year of study, average weekly exercise frequency, type of exercise, wearable device type, and fitness app usage, to control for potential confounding influences in the analysis.

TABLE I MOTIVATION ITEMS AND CONSTRUCTS

Subscale	No. of Items	Sample Item	Response Scale
Intrinsic Motivation	1	"Because I find exercise enjoyable"	0–4 (Not true for me – Very true)
Identified Regulation	3	"Because it is important to me to exercise regularly"	0–4
Introjected Regulation	4	"I feel guilty when I don't exercise"	0–4
External Regulation	4	"Other people say I should exercise"	0–4
Amotivation	8	"I don't see why I should have to exercise"	0–4

V. SAMPLE DETAILS

Data were collected via an online self-report survey administered to college students in March 2026. Participation was voluntary and anonymous. Informed consent was obtained from all respondents. The final analytical sample comprised 176 participants, all of whom provided consent and completed the core motivation items as summarised in Table 2.

Note on Demographic Distribution and Alignment with the Study Group. The demographic profile of the sample aligns closely with the intended study group of college students in higher education. The gender distribution (51.7% female, 38.6% male, 9.1% non-binary or prefer not to say) reflects the broadly mixed-gender composition typical of undergraduate student populations and is consistent with patterns reported in comparable multi-country university studies (Peltzer et al., 2014). The mean age of 20.63 years (SD = 2.72, range 17–28) is representative of the traditional college-age cohort. Year of study was distributed across all four academic levels, with Year 4 and above forming the largest group (30.1%), indicating adequate representation from both early and late-stage students.

TABLE 2 SAMPLE DEMOGRAPHIC CHARACTERISTICS

Characteristic	Category	n	%
Gender	Female	91	51.7%
	Male	68	38.6%
	Non-binary	7	4.0%
	Prefer not to say	9	5.1%
Age (years)	Mean = 20.63, SD = 2.72, Range = 17–28		
Year of Study	Year 1	41	23.3%
	Year 2	42	23.9%
	Year 3	40	22.7%
	Year 4 and above	53	30.1%
Wearable Use	yes	43	24.4%
	no		75.6%
Wearable Type (users only)	Apple Watch	16	37.2%

	Fitbit	14	32.6%
	Samsung Galaxy Watch	12	27.9%
	Other (Whoop, Boat)	2	4.7%
Fitness App Use	Yes	43	24.4%
	No	129	73.3%

The wearable use rate of 24.4% is consistent with recent estimates of consumer wearable adoption among young adults globally (Statista, 2024). Together, these characteristics indicate that the sample is appropriate for the stated research objectives and supports the generalisability of findings to similar college populations.

Additionally, fitness app usage aligned almost perfectly with wearable use ($\chi^2(1) = 131.39, p < .001$, Cramer’s V = 0.86), confirming that app use serves as a complementary indicator of digital fitness ecosystem engagement. The sample skewed slightly toward more active students: 77.3% exercised at least 3 days per week; 11.4% reported no current exercise.

VI. DESCRIPTIVE STATISTICS

Table 3 presents descriptive statistics for each BREQ-3 subscale and the RAI for the full sample and stratified by wearable use.

TABLE 3 DESCRIPTIVE STATISTICS FOR BREQ-3 SUBSCALES AND RAI

Subscale	Full Sample M (SD)	Wearable Users M (SD)	Non-Users M (SD)
Intrinsic Motivation	3.48 (1.13)	3.49 (1.32)	3.47 (1.07)
Identified Regulation	3.58 (0.98)	3.54 (1.30)	3.60 (0.85)
Introjected Regulation	1.64 (1.19)	3.12 (1.29)	1.16 (0.63)

External Regulation	1.10 (1.21)	1.07 (1.25)	1.11 (1.21)
Amotivation	0.32 (0.72)	0.49 (1.14)	0.27 (0.52)
RAI	17.49 (6.72)	18.59 (9.57)	17.13 (5.49)

The overall sample profile indicates high identified regulation (M = 3.58) and intrinsic motivation (M = 3.48), coupled with low external regulation (M = 1.10) and very low amotivation (M = 0.32), producing a robustly positive mean RAI of 17.49. This pattern is consistent with prior SDT-exercise research showing that active populations tend toward autonomous motivation profiles (Teixeira et al., 2012).

The most striking group difference is in introjected regulation, where wearable users score nearly three times higher than non-users (3.12 vs. 1.16). This large effect was the only subscale showing a practically meaningful group difference in the descriptive profile.

VII. STATISTICAL ANALYSIS

7.1 Overview of Analytical Strategy

All statistical analyses were conducted in Python 3 using the pandas, scipy, and numpy libraries. The primary grouping variable was binary wearable use (yes vs. no). Group comparisons on BREQ-3 subscales and the RAI were conducted via independent-samples t-tests as a preliminary step, followed by Mann-Whitney U tests as the primary non-parametric analysis once violations of normality were confirmed (see Section XI). A chi-square test examined the association between wearable use and fitness app adoption.

7.3 Chi-Square Test

A chi-square test of independence was conducted to examine the association between wearable use and fitness app usage. The result was highly significant: $\chi^2(1, N = 172) = 131.39, p < .001, \text{Cramer's } V = 0.87$. This near-perfect association confirms that wearable use and app use represent a unified digital fitness ecosystem in this sample; they should be treated as conceptually overlapping rather than independent predictors in future research.

7.3 Independent Samples t-Test Results

Independent samples t-tests were initially computed to provide a familiar reference point and to facilitate comparison with parametric findings in prior literature (Field, 2018). Results are summarised in Table 4.

TABLE 4 INDEPENDENT SAMPLES t-TEST RESULTS BY WEARABLE USE

Subscale	t	df	p (two-tailed)
Intrinsic Motivation	0.074	174	.941
Identified Regulation	-0.351	174	.726
Introjected Regulation	13.316	174	< .001*
External Regulation	-0.181	174	.857
Amotivation	1.798	174	.074
RAI	1.245	174	.215

Note. *Statistically significant at $p < .001$. However, due to confirmed non-normality (see Section 9), Mann-Whitney U tests are treated as the primary inferential statistic.

VIII. RELIABILITY ANALYSIS (CRONBACH'S ALPHA)

The internal consistency of the BREQ-3 was assessed using Cronbach's alpha (α) for each multi-item subscale. Because the instrument constitutes a single overarching construct, namely behavioural regulation in exercise as conceptualised within Self-Determination Theory, reliability is reported at the subscale level rather than for the instrument as a whole. The single-item intrinsic motivation subscale is excluded from this analysis, as Cronbach's alpha requires a minimum of two items. Results indicated excellent reliability across all multi-item subscales: identified regulation ($\alpha = 0.958, 3 \text{ items}$), introjected regulation ($\alpha = 0.912, 4 \text{ items}$), external regulation ($\alpha = 0.961, 4 \text{ items}$), and amotivation ($\alpha = 0.970, 8 \text{ items}$) all substantially exceeded the commonly accepted

threshold of $\alpha \geq 0.70$ for acceptable reliability (Nunnally, 1978) and met the stricter benchmark of $\alpha \geq 0.90$ associated with excellent consistency in psychometric measurement. When all 20 motivation items were treated as a single composite, the overall alpha was 0.744, which is acceptable and reflects the fact that the BREQ-3 is designed to capture qualitatively distinct motivational regulations along a continuum rather than a single unidimensional trait. Taken together, these reliability values confirm that each subscale measures its intended construct with high precision, providing a sound psychometric basis for the group comparisons that follow.

IX. NORMALITY OF DATA

The assumption of normality was assessed using the Shapiro-Wilk test, which is recommended for sample sizes below 2,000 (Field, 2018). Tests were conducted separately for wearable users and non-users on each subscale and the RAI as shown in Table 5.

TABLE 5 SHAPIRO-WILK NORMALITY TEST FOR RAI BY WEARABLE USE GROUP

Group	W Statistic	p-value	Conclusion
Wearable Users (n = 43)	0.5012	< .001	Non-normal distribution
Non-Users (n = 133)	0.7197	< .001	Non-normal distribution

Both groups displayed statistically significant departures from normality ($p < .001$), with Shapiro-Wilk W statistics substantially below 1.0. Inspection of distributions revealed a pronounced right skew in the wearable users' RAI scores and a bimodal tendency in the non-user group, likely reflecting a subgroup of non-exercisers with negative RAI values. Given these clear violations of normality, the Mann-Whitney U test was selected as the primary inferential statistic for all group comparisons, replacing the parametric t-test as the confirmatory analysis (Field, 2018).

X. INFERENCES AND FINDINGS

Table 6 presents the primary findings from the Mann-Whitney U tests comparing wearable users and non-users across all BREQ-3 subscales and the RAI.

TABLE 6 MANN-WHITNEY U TEST RESULTS: WEARABLES USERS VS NON-WEARABLE USERS

Subscale	U Statistic	p-value	Significant
Intrinsic Motivation	3041.5	.375	No
Identified Regulation	3137.5	.180	No
Introjected Regulation	4972.5	< .001	Yes*
External Regulation	2728.0	.620	No
Amotivation	3086.5	.333	No
Relative Autonomy Index (RAI)	4336.0	< .001	Yes*

Finding 1: No significant difference in overall autonomous motivation (RAI).

Contrary to the study's primary hypothesis, wearable users did not demonstrate a significantly higher RAI than non-users in the parametric t-test ($t(174) = 1.245, p = .215$). However, the Mann-Whitney U test did yield a statistically significant result ($U = 4336.0, p < .001$), indicating that when accounting for the non-normal distribution, wearable users tended to rank higher on the RAI continuum. This discrepancy warrants cautious interpretation and suggests the distribution shape, not merely central tendency — differs between groups. Wearable users showed greater variability ($SD = 9.57$) compared to non-users ($SD = 5.49$), indicating more heterogeneous motivational profiles.

Finding 2: Significant elevation in introjected regulation among wearable users.

The most robust and theoretically significant finding was a markedly higher introjected regulation score among wearable users ($M = 3.12$, $SD = 1.29$) compared to non-users ($M = 1.16$, $SD = 0.63$), confirmed by both the t-test ($t(174) = 13.316$, $p < .001$) and the Mann-Whitney U test ($U = 4972.5$, $p < .001$). Introjected regulation reflects ego-involved motivation — exercising to avoid guilt, shame, or feelings of failure (Deci & Ryan, 2000; Markland & Tobin, 2004). This finding suggests that Nonwearable-mediated goal tracking may be amplifying self-imposed pressure rather than fostering genuine enjoyment or personal valuation of exercise.

Finding 3: No significant differences in intrinsic, identified, external regulation, or amotivation.

No statistically significant differences were observed for intrinsic motivation ($U = 3041.5$, $p = .375$), identified regulation ($U = 3137.5$, $p = .180$), external regulation ($U = 2728.0$, $p = .620$), or amotivation ($U = 3086.5$, $p = .333$). This indicates that wearables are not significantly associated with either the most autonomous (intrinsic) or the most controlled (external, amotivation) ends of the SDT continuum in this sample.

Finding 4: Near-perfect association between wearable use and fitness app adoption.

The chi-square analysis confirmed an extremely strong association between wearable device use and fitness app use ($\chi^2(1) = 131.39$, $p < .001$, Cramer's $V = 0.87$), underscoring that these constructs represent a unified digital fitness ecosystem rather than independent variables. This has implications for both construct validity and future research design.

XI. MANAGERIAL IMPLICATIONS

The findings carry practical implications for technology designers, university health programmers, and public health practitioners.

For wearable technology designers. The elevated introjected regulation among wearable users signals a design risk: features such as daily step-count streaks, shame-inducing sedentary reminders, and failure notifications may be inadvertently amplifying guilt-based motivation (Etkin, 2016; Lyons et al., 2014).

Based on SDT (Deci & Ryan, 2000), designers should prioritise autonomy-supportive features: allowing users to set their own flexible goals, offering competence-affirming feedback that celebrates effort rather than punishing shortfall, and enabling social relatedness through cooperative rather than competitive challenges.

For university wellness programmes. Campus health promoters should not assume that distributing or incentivising wearable devices will automatically translate into autonomous, sustained exercise motivation. Wearable adoption should be paired with motivational education, helping students understand and reflect on why they exercise, rather than relying solely on the device's behavioural feedback loops (Teixeira et al., 2012). Counselling or group-based reflective sessions grounded in Motivational Interviewing may complement wearable use to shift students from introjected toward identified or intrinsic regulation.

For fitness app developers. Given the near-perfect overlap between wearable and app use in this sample, app-level interventions are likely to reach essentially all wearable users. Embedding brief need-supportive content such as short reflective prompts on why a user values movement, celebrating personal bests rather than social comparisons, within the app interface could be a cost-effective strategy to shift the motivational register from controlled to autonomous (Firth et al., 2017; Shin & Biocca, 2017).

XII. THEORETICAL IMPLICATION

This study extends the SDT-exercise literature in several theoretically important ways.

Challenging the autonomous motivation hypothesis. The commonly assumed pathway that wearables enhance perceived competence, which in turn fosters autonomous motivation (Shin & Biocca, 2017) was not supported by the intrinsic or identified regulation data. The statistically non-significant differences in these subscales suggest that the competence-enhancing mechanism of wearable feedback may not be strong enough to shift motivational quality in a cross-sectional college sample, or that compensating factors neutralise any competence gain.

The introjected regulation paradox. The large and robust elevation in introjected regulation among wearable users is the most theoretically provocative

finding. It is consistent with Etkin's (2016) experimental finding that tracking an inherently enjoyable activity reduces subsequent intrinsic motivation by making it feel more like work. Within SDT, introjected regulation is classified as a controlled form of motivation (Deci & Ryan, 2000), meaning that despite a positive mean RAI, wearable users may be exercising for the wrong reasons, to avoid self-criticism rather than from genuine interest. Longitudinal research is needed to determine whether this pattern precedes device adoption (selection effect) or is produced by it (device effect).

Methodological contribution: RAI distributions matter. The significant Mann-Whitney U result for the RAI, alongside a non-significant t-test, highlights that group differences in exercise motivation may manifest in distributional shape rather than mean differences alone. Future SDT research should examine the full distribution of RAI scores including variance, skewness, and modality, rather than relying solely on mean comparisons (Field, 2018).

Call for longitudinal and experimental designs. The cross-sectional design of this study precludes causal inference. The association between wearable use and elevated introjected regulation could reflect reverse causality. A randomised controlled trial assigning students to wearable versus no-wearable conditions over a semester would be the gold standard for establishing causal direction (Teixeira et al., 2012).

REFERENCES

- [1] D. M. Bravata, C. Smith-Spangler, V. Sundaram, et al., "Using pedometers to increase physical activity and improve health: A systematic review," *JAMA*, vol. 298, no. 19, pp. 2296–2304, 2007. [Online]. Available: <https://doi.org/10.1001/jama.298.19.2296>
- [2] E. L. Deci and R. M. Ryan, *Intrinsic Motivation and Self-Determination in Human Behavior*. New York, NY, USA: Plenum Press, 1985.
- [3] E. L. Deci and R. M. Ryan, "The 'what' and 'why' of goal pursuits: Human needs and the self-determination of behavior," *Psychol. Inq.*, vol. 11, no. 4, pp. 227–268, 2000. [Online]. Available: https://doi.org/10.1207/S15327965PLI1104_01
- [4] J. Etkin, "The hidden cost of personal quantification," *J. Consum. Res.*, vol. 42, no. 6, pp. 967–984, 2016. [Online]. Available: <https://doi.org/10.1093/jcr/ucv095>
- [5] A. Field, *Discovering Statistics Using IBM SPSS Statistics*, 5th ed. London, UK: SAGE Publications, 2018.
- [6] J. Firth, J. Torous, J. Nicholas, et al., "Can smartphone mental health interventions reduce symptoms of anxiety? A meta-analysis of randomized controlled trials," *J. Affect. Disord.*, vol. 218, pp. 15–22, 2017. [Online]. Available: <https://doi.org/10.1016/j.jad.2017.04.046>
- [7] X. D. Keating, J. Guan, J. C. Piñero, and D. M. Bridges, "A meta-analysis of college students' physical activity behaviors," *J. Amer. Coll. Health*, vol. 54, no. 2, pp. 116–125, 2005. [Online]. Available: <https://doi.org/10.3200/JACH.54.2.116-126>
- [8] E. J. Lyons, Z. H. Lewis, B. G. Mayrsohn, and J. L. Rowland, "Behavior change techniques implemented in electronic lifestyle activity monitors: A systematic content analysis," *J. Med. Internet Res.*, vol. 16, no. 8, p. e192, 2014. [Online]. Available: <https://doi.org/10.2196/jmir.3469>
- [9] D. Markland and V. Tobin, "A modification to the Behavioural Regulation in Exercise Questionnaire to include an assessment of amotivation," *J. Sport Exerc. Psychol.*, vol. 26, no. 2, pp. 191–196, 2004. [Online]. Available: <https://doi.org/10.1123/jsep.26.2.191>
- [10] E. Mullan, D. Markland, and D. K. Ingledew, "A graded conceptualisation of self-determination in the regulation of exercise behaviour: Development of a measure using confirmatory factor analytic procedures," *Pers. Individ. Dif.*, vol. 23, no. 5, pp. 745–752, 1997. [Online]. Available: [https://doi.org/10.1016/S0191-8869\(97\)00107-4](https://doi.org/10.1016/S0191-8869(97)00107-4)
- [11] J. C. Nunnally, *Psychometric Theory*, 2nd ed. New York, NY, USA: McGraw-Hill, 1978.
- [12] K. Peltzer, S. Pengpid, T. A. Samuels, et al., "Prevalence of overweight/obesity and its associated factors among university students from 22 countries," *Int. J. Environ. Res. Public Health*, vol. 11, no. 7, pp. 7425–7441, 2014. [Online]. Available: <https://doi.org/10.3390/ijerph110707425>
- [13] J. F. Sallis, J. J. Prochaska, and W. C. Taylor, "A review of correlates of physical activity of

- children and adolescents," *Med. Sci. Sports Exerc.*, vol. 32, no. 5, pp. 963–975, 2000. [Online]. Available: <https://doi.org/10.1097/00005768-200005000-00014>
- [14] D. Shin and F. Biocca, "Health experience model of personal informatics: The case of a quantified self," *Comput. Hum. Behav.*, vol. 69, pp. 62–74, 2017. [Online]. Available: <https://doi.org/10.1016/j.chb.2016.12.019>
- [15] Statista, "Wearable technology — Global revenue 2019–2028," Statista Research Department, 2024. [Online]. Available: <https://www.statista.com/statistics/975482/world-wide-wearable-device-market-size/>
- [16] P. J. Teixeira, E. V. Carraça, D. Markland, et al., "Exercise, physical activity, and self-determination theory: A systematic review," *Int. J. Behav. Nutr. Phys. Act.*, vol. 9, art. no. 78, 2012. [Online]. Available: <https://doi.org/10.1186/1479-5868-9-78>
- [17] P. M. Wilson, W. M. Rodgers, C. C. Loitz, and G. Scime, "'It's who I am...really!' The importance of integrated regulation in exercise contexts," *J. Appl. Biobehav. Res.*, vol. 11, no. 2, pp. 79–104, 2006. [Online]. Available: <https://doi.org/10.1111/j.1751-9861.2006.tb00021.x>
- [18] World Health Organization, "Physical activity," Oct. 5, 2022. [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/physical-activity>
- [19] World Health Organization. (2022). Physical activity. WHO Fact Sheet. <https://www.who.int/news-room/fact-sheets/detail/physical-activity>