RESEARCH PAPER

Comparative Analysis of Walking Cadence and Heart Rate Reserve in Structured Gym-Exercise and Non-Structured Activity Groups: An Observational Study

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ABSTRACT

Purpose: Physical inactivity is a primary contributor to reduced cardiovascular and functional health. This study evaluates walking cadence as a primary functional marker and heart rate reserve (HRR) as a secondary physiological marker of fitness, comparing adults aged 18–45 years engaged in structured gym-based exercise with those in non-structured activity patterns.

Methods: A cross-sectional study was conducted among 400 participants. Subjects were categorized into a Gym Going and a Non-Gym Going Group (<150 min/week of moderate activity). Cadence was measured during a self-selected brisk walk (primary outcome), and HRR was assessed as a secondary exploratory physiological marker using the Karvonen formula.

Results: The Gym going group was significantly younger (24.65 ±6.85 years) than the non-Gym going group (34.85 ±8.86 years; $p < 0.001$). Regarding the primary outcome, walking cadence was significantly higher in the structured gym-exercise group (118.98 ±7.61 steps/min) compared to the non-structured group (98.79 ±7.92 steps/min; $p < 0.001$). Similarly, the secondary physiological marker, HRR, was significantly higher in the structured exercise cohort (115.85 ±9.71 bpm) than in the non-structured cohort (106.63 ±12.09 bpm; $p < 0.001$).

Conclusion: Structured gym-based exercise was associated with significantly higher walking cadence and HRR. While the findings are influenced by age differences, these parameters provide a non-invasive, clinically feasible approach to assessing functional and cardiovascular fitness in adults.

Keywords: Walking Cadence, Heart Rate Reserve, Structured Exercise, Non-Structured Activity, Physical Fitness, Observational Study

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INTRODUCTION

Physical inactivity is a global health crisis, contributing to nearly 3.2 million deaths annually [(1)]. Prolonged sedentary behaviours leads to a decline in cardiovascular efficiency and neuromuscular coordination [(2)]. While maximal oxygen uptake (VO_2 max) remains the gold standard for fitness assessment, its clinical application is often limited by specialized equipment needs and high costs [(3)]. Consequently, there is an urgent need for simple, reproducible markers for routine screening [(4)].

Walking cadence, defined as steps per minute, has emerged as a practical proxy for physical activity intensity and functional walking performance [(5)]. It reflects the integration of central nervous system motor control and musculoskeletal power [(6)]. Heart Rate Reserve (HRR), the difference between maximal and resting heart rate, serves as a secondary indicator of autonomic balance and cardiovascular adaptability [(7)].

The “physical activity paradox” suggests that structured, intentional exercise confers distinct physiological benefits compared to incidental daily

activity [8]. This study compares individuals aged 18–45 years engaging in structured gym-based exercise with those in non-structured low-activity patterns to determine if formal training environments translate to higher functional and physiological markers [9, 10].

MATERIALS AND METHODS

Study Design and Ethical Approval

This cross-sectional study was approved by the Institutional Ethics Committee (Approval No: BV(DU)MC&H/Sangli/IEC/Phy-45/25). Informed consent was obtained from all 400 participants.

Operational Definitions and Grouping

Group allocation was based on self-reported exercise history and weekly activity patterns, verified through a structured screening form before enrolment.

1. **Gym Going Group (n=200):** Participants performing supervised or self-directed facility-based resistance and/or aerobic exercise for 150 minutes/week, at least 3 sessions/week, for 3 months (11).
2. **Non- Gym Going Group (n=200):** Participants not engaged in any structured exercise program and reporting < 150 minutes/week of moderate-intensity physical activity (12).

Screening Criteria: Participants were screened for regular sports, running, yoga, dance, martial arts, physically demanding occupational work, or home-based structured exercise wherever reported, to reduce misclassification.

Outcome Measures

1. **Cadence (Primary Outcome):** Measured as steps/min during a self-selected brisk walk over a 100-meter track using manual step counting and a standardized stopwatch protocol (13).
2. **Heart Rate Reserve (Secondary Outcome):** HRR was assessed as a secondary exploratory physiological parameter. It was calculated using the Karvonen formula (14):

HR_{max} = 220 - age

HRR = HR_{max} - HR_{rest}

Resting HR was recorded after 5 minutes of seated rest using a pulse oximeter.

Statistical Analysis

Data were analysed using SPSS v25. Normality was assessed before analysis. Normally distributed variables were compared using independent t-tests, while non-normally distributed variables were compared using the Mann–Whitney U test. Significance was set at $p < 0.05$.

RESULTS

Table 1: Baseline Characteristics of Participants

Variable	Gym Going (n=200)	Non-Gym Going (n=200)	p-value
Age (Years)	24.65 ± 6.85	34.85 ± 8.86	< 0.001

The structured gym-exercise group was significantly younger than the non-structured low-activity group. Therefore, age was considered an important potential confounder while interpreting the findings.

Table 2: Comparison of Primary and Secondary Outcomes

Parameter	Gym Going (n=200)	Non-Gym Going (n=200)	p-value
Cadence (steps/min)	**118.98 ± 7.61**	**98.79 ± 7.92**	**< 0.001**
Heart Rate Reserve (bpm)	**115.85 ± 9.71**	**106.63 ± 12.09**	**< 0.001**

Cadence, the primary outcome, was significantly higher in the structured gym-exercise group. The mean difference was approximately 20 steps/min, representing a substantial difference in functional walking performance. HRR, the secondary outcome, was also significantly higher, suggesting better cardiovascular reserve in the structured exercise group.

DISCUSSION

Principal Findings

This study demonstrates that structured facility-based exercise is associated with significantly higher functional and physiological markers in adults aged 18–45 years. The structured gym-exercise group exhibited a cadence nearly 20% higher and a robustly expanded HRR compared to the non-structured group.

Cadence as a Functional Fitness Marker

The higher cadence observed in the structured exercise group (~119 steps/min) may suggest better neuromuscular efficiency and lower-limb power [15]. This value is consistent with the "vigorous" intensity threshold described in previous gait literature [16]. The structured nature of gym training likely tunes the musculoskeletal system for more efficient gait turnover compared to incidental activity [17].

HRR as a Secondary Cardiovascular Marker

The higher HRR in the structured exercise group reflects better cardiovascular reserve [18]. While age-

predicted maximal heart rate was used, the higher HRR values are consistent with exercise-related adaptations such as increased stroke volume and improved cardiac-vagal regulation [19]. These adaptations may contribute to better cardiovascular efficiency and metabolic health [20].

Comparison with Existing Literature

Our findings align with studies by Tudor-Locke et al., who established that cadences above 110 steps/min generally correlate with vigorous-intensity activity [5, 15]. Furthermore, the autonomic adaptations reflected in the HRR results are consistent with standard guidelines emphasizing structured exercise for improving cardiorespiratory fitness [9].

Strengths and Clinical Implications

The main strength of this study is the use of simple, clinically feasible, low-cost measures in a relatively large sample. Cadence and HRR may serve as rapid screening tools in outpatient settings to identify individuals lacking functional and cardiovascular reserve.

LIMITATIONS

1. **Confounding:** The structured exercise group was significantly younger. This represents an important potential confounder as age influences gait performance and cardiovascular reserve.
2. **Classification Bias:** Grouping was based on gym attendance and self-reported levels, which may not fully capture total physical activity.
3. **Measurement Precision:** Manual cadence counting and age-predicted HRmax are estimated markers rather than direct physiological measures.
4. **Study Design:** The cross-sectional design cannot establish causality.

CONCLUSION

Structured gym-based exercise was associated with significantly higher walking cadence, the primary functional outcome, and higher HRR, the secondary physiological marker. These simple measures may be useful for screening fitness in adults. However, findings should be interpreted in view of the age difference between groups and the cross-sectional design. Future studies using age-matched groups, objective physical activity monitoring, and direct cardiorespiratory testing are recommended.

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