

ORIGINAL ARTICLE

Physical Fitness and Activity Status Among Community-Dwelling Individuals with Spinal Cord Injury in the Klang Valley, Malaysia

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ABSTRACT

Background and Objective: Spinal cord injury (SCI) often results in long-term impairments in physical function and mobility, underscoring the importance of understanding physical fitness and activity levels among community-dwelling individuals to inform rehabilitation planning. This study aimed to determine the physical fitness and physical activity levels of community-dwelling individuals with SCI and to examine the relationship between these variables. **Methods:** A cross-sectional study was conducted among individuals with SCI residing in the Klang Valley, including Kuala Lumpur, Petaling Jaya, Shah Alam, and Putrajaya. Sociodemographic information was collected via online forms and email responses. Physical fitness was assessed using measures of upper-limb strength, handgrip strength, and predicted peak oxygen uptake, measured with a handheld dynamometer, a handgrip dynamometer, and the 6-minute wheelchair push test, respectively. Physical activity levels were evaluated using a validated questionnaire designed for individuals with physical disabilities. **Results:** Participants demonstrated a mean handgrip strength of 32.00 (15.11) kg, a mean shoulder flexor strength of 15.08 (7.35) kg, and a mean predicted peak oxygen uptake of 2152.22 (384.44) mL/min. Physical activity levels were classified as moderate, with a mean score of 54.65 (33.20). No significant correlations were observed between physical fitness measures and physical activity levels. Male participants exhibited higher physical activity scores and higher predicted peak oxygen uptake than females; however, these differences were not statistically significant. **Conclusions:** Among community-dwelling individuals with SCI, physical fitness and physical activity levels were not significantly associated. These findings suggest that participation in physical activity may not directly reflect fitness status in this population. Future studies with larger and more diverse samples are recommended to elucidate these relationships across different demographic and functional subgroups.

Keywords: spinal cord injury; community; physical fitness; physical activity; rehabilitation; Malaysia

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INTRODUCTION

Spinal cord injury (SCI) is a complex neurological condition characterised by varying degrees of motor and sensory impairment that substantially affect physical function, independence, and long-term mobility (Ahuja et al., 2017; Motiei-Langroudi & Sadeghian, 2017). SCI may result from traumatic causes, including motor vehicle accidents, falls, and sports-related injuries (Inamasu, 2022; Ning et al., 2012; Algahtany et al., 2021; Yuan et al., 2023), or from non-traumatic aetiologies such as degenerative spinal disorders, myelopathy, and systemic diseases

(Kumar & Gupta, 2016; Choi & Kang, 2020; Yang et al., 2019; Zou et al., 2020). Beyond the primary neurological insult, individuals with SCI commonly experience secondary complications, including chronic pain, neurogenic bowel and bladder dysfunction, reduced muscular strength, impaired cardiorespiratory fitness, decreased endurance, and restricted mobility (Shen et al., 2020; Kirchberger et al., 2010; Cieza et al., 2010). These impairments significantly limit participation in activities of daily living, community engagement, employment, and overall quality of life (Carpenter et al., 2007; Manaf et al., 2018; Hearn & Cross, 2020).

Physical fitness is a multidimensional construct encompassing muscular strength, cardiorespiratory endurance, flexibility, and functional mobility, and is a key determinant of independence and long-term health in individuals with SCI (Edwards et al., 2017). Among wheelchair users, upper limb strength plays a critical role in mobility, transfers, and self-care activities, while handgrip strength is a robust indicator of overall muscular function and functional independence. Cardiorespiratory fitness, commonly estimated using predicted peak oxygen uptake, reflects the capacity to sustain prolonged physical activity and is closely associated with cardiovascular health and fatigue resistance. Collectively, measures of upper limb strength, handgrip strength, and predicted peak oxygen uptake provide a comprehensive representation of muscular and cardiorespiratory fitness in individuals with SCI and have been linked to functional outcomes, including mobility performance, participation in daily activities, and quality of life.

Initiation and progression of upper-limb strengthening, handgrip training, and cardiorespiratory conditioning are typically recommended once individuals with SCI achieve medical stability and sufficient neuromusculoskeletal capacity, most commonly during the subacute and chronic phases of recovery. Early and appropriately prescribed fitness training is important to minimise deconditioning, support functional recovery, and promote sustained engagement in physical activity. However, community-dwelling individuals with SCI often encounter substantial barriers to maintaining physical fitness, including limited access to rehabilitation and exercise facilities, transportation difficulties, environmental constraints, and a high reliance on the upper limbs for mobility and daily tasks (Haisma et al., 2006; Scheel-Sailer et al., 2021). These barriers frequently contribute to sedentary behaviour, further exacerbating declines in physical fitness and participation.

In Malaysia, evidence on physical fitness among individuals with SCI remains limited, with most local research focusing primarily on physical activity behaviour. Previous studies have reported low mean scores on the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) among subacute and chronic SCI populations, with values of 23.45 MET hour·day⁻¹ and 21.29 MET hour·day⁻¹, respectively (Hisham et al., 2022; Mat Rosly et al., 2020). While these findings highlight low levels of physical activity, they do not capture broader components of physical fitness or clarify how fitness status relates to physical activity behaviour in real-world community settings. Furthermore, potential confounding factors such as body composition, including body mass index (BMI) and body weight, may influence both physical fitness and physical activity levels by affecting movement efficiency, upper

limb loading, and cardiovascular demand; however, these factors have not been adequately examined or discussed in local studies.

To date, the physical fitness status of community-dwelling individuals with SCI and its relationship with physical activity levels remain poorly understood in the Klang Valley. As a highly urbanised region, the Klang Valley presents unique environmental, accessibility, socioeconomic, and lifestyle challenges that may differentially influence physical activity participation and physical fitness outcomes. Understanding the interrelationships among physical fitness, physical activity, and potential confounding variables, such as body composition, is essential for informing community-based rehabilitation strategies, optimising exercise prescription, and guiding health policy aimed at improving function and quality of life among individuals with SCI. Therefore, the objective of this study was to determine physical activity levels, evaluate physical fitness status, and examine the relationships between physical fitness and physical activity among community-dwelling individuals with SCI in the Klang Valley.

MATERIALS & METHODS

Study Design

This study employed a cross-sectional design involving community-dwelling individuals with spinal cord injury (SCI) residing in the Klang Valley, Malaysia. Data were collected at a single time point to assess participants' physical fitness status and physical activity levels in this urban region. Cross-sectional designs are appropriate for describing current patterns and associations at a single time point, although they do not establish causality (Kesmodel, 2018; Pandis, 2014). Recruitment involved individuals with SCI who were living independently in the community, enabling the study to reflect real-world functional and lifestyle conditions unique to the Klang Valley population, which comprises major urban centres including Kuala Lumpur, Putrajaya, Petaling Jaya, Shah Alam, Klang, Subang Jaya, and Cyberjaya.

Participants

The study population consisted of individuals with spinal cord injury (SCI) living independently within communities in the Klang Valley, Malaysia. Participants were recruited through convenience sampling. Recruitment was conducted through contact lists from healthcare personnel and non-governmental organizations (NGOs), particularly the Malaysian Advocacy of Spinal Injury Association (MAASA). Individuals identified through these sources who met the eligibility requirements were invited to participate until the desired sample size was achieved. This approach enabled the inclusion of a diverse group of community-dwelling individuals with SCI across the Klang Valley.

Inclusion Criteria

Participants were included if they were diagnosed with SCI and had been discharged from inpatient

rehabilitation for at least one year. Eligible participants were between 18 and 55 years old, wheelchair-dependent for mobility, classified as AIS A, B, or C, and able to understand, read, and communicate in either Malay or English.

Exclusion Criteria

Participants were excluded if they were pregnant, receiving psychiatric intervention, diagnosed with a mental disorder, or had a progressive neurological disease.

Sample Size

The required sample size was estimated using G*Power software. A linear multiple regression (fixed model) with an F-test was selected as the statistical framework to examine the relationship between physical fitness and physical activity. Using an alpha level of 0.05 and a medium effect size, the minimum sample size required to achieve adequate statistical power was 68 participants. To account for a potential 30% dropout or non-response rate, a total recruitment target of 88 participants was planned.

Data Collection

Data collection was conducted in community settings in the Klang Valley through health screenings. The study procedure and informed consent were explained to participants before initiation. To minimise assessor bias related to knowledge and practice, all measurements were conducted by a single trained assessor using standardised protocols and predefined testing positions, and the assessor was blinded to participants' PASIPD physical activity scores.

The data collection was divided into two parts. During the first part, sociodemographic information was collected, including coded names, age, gender, race, marital status, years since injury, level of injury (C1–S5), state and area of residence, educational background, employment status, and household income. Body weight and height were also recorded to calculate body mass index (BMI), which was considered a potential confounding variable influencing physical fitness and physical activity outcomes.

Following this, evaluation of physical activity levels and physical capacity was conducted. Physical fitness was assessed by examining muscle strength and aerobic fitness.

Physical Fitness

Upper Limb Muscle Strength

Upper limb muscle strength was assessed using the "MAKE" (Maximum Voluntary Isometric Contraction) test with the MicroFET2™ handheld dynamometer (Hoggan Scientific, LLC). The MicroFET2™ has demonstrated good to excellent validity, reliability, and sensitivity for assessing upper extremity muscle

strength in individuals with SCI, with reported intra-rater reliability coefficients ranging from 0.85 to 0.96 (Douma et al., 2014).

Participants were positioned supine and instructed to isolate and contract the tested muscle groups in accordance with standardised testing positions. The assessor maintained a stable position to resist the participant's force. Upon the verbal command "1, 2, 3, go," participants exerted maximal force against the device for 3–5 seconds. Each muscle group was tested three times on both dominant and non-dominant sides, and the mean value was calculated.

Handgrip Strength

Handgrip strength was measured using a JAMAR hand dynamometer with participants seated in their wheelchairs. Handgrip strength is recognised as a valid and sensitive indicator of overall upper limb muscular function and functional independence in individuals with SCI. Measurements were repeated three times for each hand, and average values were recorded.

Participants maintained an erect posture with the shoulder in 30° abduction, elbow in 90° flexion, and forearm in a neutral position. Rest intervals of 15–60 seconds were provided between trials to minimise fatigue. The JAMAR hand dynamometer has demonstrated strong reliability (Spearman correlation = 0.82) and validity ($r = 0.75$) in SCI populations (Mathiowetz, 2002).

Cardiorespiratory Fitness

Cardiorespiratory fitness was assessed using a 6-minute wheelchair push test (6-MPT) performed on an arm ergometer (MOTomed Viva 2). The 6-MPT has demonstrated strong reliability and validity for estimating aerobic capacity in individuals with SCI (Hol et al., 2007).

Participants remained seated in their personal wheelchairs, which were stabilised prior to testing. The ergometer axis was aligned with the xiphoid process, allowing full elbow extension during arm cranking. A standardised warm-up was performed, followed by a 6-minute submaximal test with progressive workload increments based on injury level. Heart rate was continuously monitored, and steady-state values were recorded during the final 30 seconds of the test.

Predicted peak oxygen uptake (VO_{2max}) was estimated using the Abadie and Schuler submaximal arm-crank prediction equation, which has been validated against directly measured VO_{2max} (Abadie & Schuler, 1999).

Physical Activity Levels

Physical activity levels were assessed using the Malaysian-adapted Physical Activity Scale for Individuals with Physical Disabilities (PASIPD). The PASIPD has demonstrated acceptable validity and reliability in individuals with SCI (Cronbach's alpha = 0.37–0.65; Spearman correlation = 0.77) (Washburn et

al., 2002; Mat Rosly et al., 2020). Scores were calculated in MET-hours per day.

Statistical Analysis

Data were analysed using SPSS software. Descriptive statistics (means and standard deviations) were used for continuous variables, while categorical variables were summarised using frequencies and percentages. Normality was assessed using the Shapiro–Wilk test and visual inspection of data distribution. Variables that were not normally distributed were analysed using non-parametric methods.

Spearman’s rank correlation coefficient (ρ) was applied for non-normally distributed data, while Pearson’s correlation coefficient was used for normally distributed continuous variables. Differences between male and female participants were analysed using independent t-tests or Mann–Whitney U tests as appropriate.

The level of significance was set at $p < 0.05$, and correlation strength was interpreted according to Cohen’s guidelines as small ($r < 0.10$), moderate ($r < 0.30$), or large ($r > 0.50$).

RESULTS

Participants Characteristics

This cross-sectional study included 13 participants ($n = 13$) with a mean age of 35.08 years ($SD = 6.37$). The demographic characteristics of participants are presented in Table 1. Most participants were male (9 participants, 69.2%). All participants were Malay (100%), and 4 participants (30.8%) were single. The majority of participants (12 participants, 92.3%) had tetraplegia. Participants had been living with spinal cord injury for a mean duration of 14.62 years ($SD = 8.74$).

Participants were predominantly residents of Selangor (11 participants, 84.6%), with smaller proportions residing in Kuala Lumpur (2 participants, 15.4%) and Putrajaya (2 participants, 15.4%). Educational attainment varied, with 1 participant (7.7%) having completed primary education, 4 participants (30.8%) secondary education, 1 participant (7.7%) holding a diploma, 4 participants (30.8%) holding a bachelor’s degree, 2 participants (15.4%) holding a master’s degree, and 1 participant (7.7%) holding a professional or doctoral qualification. The majority of participants were employed (8 participants, 61.5%), followed by self-employed (3 participants, 23.1%), while 1 participant (7.7%) was unemployed. The mean household income was RM 3,700.00 ($SD = RM 1,712.05$) (Table 1).

Table 1: Demographic Data & Characteristics of Participants

Participants (n=13)	Mean (SD) or Number of Participants
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Study Characteristics		(%)
Age		35.08 (6.370)
		years old
Male		9 (69.2)
Malay		13 (100)
Single		4 (30.8)
Tetraplegia		12 (92.3)
Years since injury		14.62 (8.74)
		years
State	Selangor	11 (84.6)
	Kuala Lumpur	2 (15.4)
Educational Level	Primary School	1 (7.7)
	Secondary School	4 (30.8)
	Diploma Holder	1 (7.7)
	Degree Holder	4 (30.8)
	Master’s Degree	2 (15.4)
Employment Status	Professional/Doctoral Degree	1 (7.7)
	Employed	8 (61.5)
	Self-employed	3 (23.1)
	Unemployed	1 (7.7)
Amount of household income		RM 3700.00 (1712.05)

Physical Fitness and Activity Level

Table 1 presents the descriptive statistics for physical fitness and physical activity outcomes. The mean handgrip strength (HGS) was 32.00 kg ($SD = 15.11$). Among shoulder muscle groups, shoulder flexor strength demonstrated the highest mean value (15.08 kg, $SD = 7.35$), followed by shoulder abductors (13.09 kg, $SD = 6.81$) and shoulder extensors (12.63 kg, $SD = 5.32$). The mean predicted peak oxygen uptake (VO_2max) was 2152.22 mL/min ($SD = 384.44$). The mean Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) score was 54.65 MET h·day⁻¹ ($SD = 33.20$), indicating a moderate level of physical activity (Table 2).

Table 2: Physical Fitness and Activity Level

Participants (n=13)	Mean (SD)
HGS (kg)	32.00(15.11)
Sh. Flexors (kg)	15.08 (7.35)
Sh. Abductor (kg)	13.09(6.81)
Sh. Extensor (kg)	12.63 (5.32)
VO2Max (mL/min)	2152.22(384.44)
Physical activity level (MET h day ⁻¹)	54.65 (33.20)

Cardiorespiratory Fitness Associations with Physical Activity Level

A Spearman’s rank-order correlation was conducted to examine the relationship between predicted peak oxygen uptake (VO₂max) and physical activity level among 13 participants. A moderate positive correlation was observed (rs = 0.55). However, this association was not statistically significant (p = 0.05, rounded to two decimal places). Although the correlation coefficient suggests a meaningful relationship, the lack of statistical significance may be attributed to the small sample size, which limits statistical power (Table 3).

Physical Activity Level Associations with Muscle Strength and Handgrip Strength

A Spearman’s rank-order correlation analysis was performed to examine the association between shoulder flexor muscle strength and physical activity level. A weak-to-moderate positive correlation was observed (rs = 0.36, p = 0.23), which was not statistically significant. Similarly, a Spearman’s rank-order correlation was conducted to examine the relationship between handgrip strength and physical activity level. A weak positive correlation was identified (rs = 0.22, p = 0.47), but it was not statistically significant (Table 3).

Gender Associations with Cardiovascular Fitness and Physical Activity Level

A point-biserial correlation analysis was conducted to examine the association between gender and predicted peak oxygen uptake (VO₂max). A moderate negative correlation was observed (r = -0.55, n = 13); however, this relationship was not statistically significant (p = 0.05, rounded to two decimal places). The proximity of the p-value to the conventional significance threshold suggests that this association may have reached statistical significance with a larger sample size. A further point-biserial correlation analysis examined the relationship between gender and physical activity level. A very weak negative correlation was observed (r = -0.00, n = 13), which was not statistically significant (p = 1.00) (Table 3).

Table 3. Correlations Between Physical Fitness Measures and Physical Activity Level (n = 13)

Variables Compared	Correlation Test	Correlation Coefficient (r / rs)	p-value
VO ₂ max vs Physical Activity Level (PASIPD)	Spearman’s rho	rs = 0.55	0.05
Shoulder Flexor Strength vs Physical Activity Level (PASIPD)	Spearman’s rho	rs = 0.36	0.23
Handgrip Strength vs Physical Activity Level (PASIPD)	Spearman’s rho	rs = 0.22	0.47
Gender vs VO ₂ max	Point-biserial correlation	r = -0.55	0.05
Gender vs Physical Activity Level (PASIPD)	Point-biserial correlation	r = -0.00	1.00

Abbreviations: VO₂max = predicted peak oxygen uptake; PASIPD = Physical Activity Scale for Individuals with Physical Disabilities; rs = Spearman’s rank correlation coefficient.

DISCUSSION

Impact of Demographic and Clinical Factors

This study examined physical fitness and physical activity levels among community-dwelling individuals with spinal cord injury (SCI) and explored the relationships between these variables. The findings indicate that although moderate positive associations were observed between predicted peak oxygen uptake (VO₂max) and physical activity level, as well as between muscle strength measures and physical activity, none of these relationships reached statistical significance. These findings highlight the complex and multifactorial nature of physical activity behaviour and fitness outcomes in individuals with SCI. Demographic and clinical characteristics may have influenced the observed patterns. The study sample was relatively young, predominantly male, and largely composed of individuals with tetraplegia and long-standing injury duration. Previous research suggests that age, sex, injury level and completeness, and time since injury play important roles in determining physical fitness

capacity and activity participation. Individuals with higher-level injuries, particularly tetraplegia, typically demonstrate reduced upper-limb muscle mass, lower aerobic capacity, and increased reliance on compensatory strategies, which may limit both fitness performance and habitual physical activity. The long duration since injury observed in this sample may also reflect adaptations to chronic disability, in which individuals adopt stable yet potentially low-intensity activity patterns over time.

Influence of Body Composition and Safety Considerations

Body composition, particularly body mass index (BMI) and body weight, is an important factor influencing both physical fitness and physical activity in individuals with SCI. Higher body mass may increase the mechanical and metabolic demands placed on the upper limbs during wheelchair propulsion and arm-based exercise, potentially affecting cardiorespiratory fitness test performance and perceived exertion. From a safety perspective, individuals with higher BMI may be at increased risk of early fatigue, musculoskeletal strain, or cardiovascular stress during aerobic testing. Although BMI was recorded in this study, the small sample size limited the ability to statistically adjust for its influence. Nevertheless, future studies should explicitly examine the role of body composition when interpreting fitness outcomes and designing safe, individualised exercise protocols for people with SCI.

Physical Activity Patterns and Participation

Despite demonstrating moderate levels of physical activity as measured by PASIPD, participants did not show strong associations between activity levels and objective fitness measures. This finding suggests that habitual physical activity among community-dwelling individuals with SCI may consist largely of low-to-moderate intensity activities that are insufficient to elicit substantial improvements in muscular strength or cardiorespiratory fitness. The PASIPD captures a broad range of activities, including household and occupational tasks, which may contribute to overall activity scores but not necessarily reflect structured or fitness-enhancing exercise. In addition, participation in physical activity among individuals with SCI is often influenced by multiple environmental and psychosocial factors, including accessibility barriers, transportation limitations, availability of adaptive exercise facilities, social support, and motivation. These barriers may contribute to variability in activity participation and help explain the lack of statistically significant associations observed in this study.

Implications for Rehabilitation and Community Health

The findings of this study have important implications for physiotherapy practice and community-based rehabilitation. The lack of strong correlations between physical activity level and physical fitness underscores

the need for targeted exercise interventions rather than relying solely on general physical activity. Physiotherapists should emphasise structured, progressive upper limb strengthening and cardiorespiratory training programmes tailored to injury level, functional capacity, and individual goals. From a community health perspective, promoting long-term engagement in appropriate physical activity is essential for maintaining cardiovascular health, preserving upper limb function, and supporting psychosocial well-being among individuals with SCI. Community-based exercise programmes, accessible facilities, and education on safe and effective exercise prescription may help bridge the gap between physical activity participation and meaningful fitness gains. Future research with larger, more diverse samples is needed to further clarify these relationships and identify subgroups of individuals with SCI who may be at greater risk of physical inactivity or reduced fitness.

Limitations

Several limitations should be considered when interpreting the findings of this study. First, the small sample size ($n = 13$) substantially limited the statistical power to detect significant associations and reduced the generalisability of the results. Recruitment of community-dwelling individuals with spinal cord injury (SCI), particularly within densely populated urban regions such as the Klang Valley, was challenging due to accessibility constraints, transportation limitations, and the geographically dispersed nature of potential participants. Many individuals with SCI experience mobility restrictions, depend on caregivers, or encounter environmental barriers that limit their ability to travel to assessment sites, thereby reducing the feasibility of recruitment. Second, conducting physical fitness assessments in community settings posed significant logistical challenges. The MOTomed Viva 2, used to assess cardiorespiratory fitness, is a large, non-portable device that restricts its transport to participants' homes or community centres. This limitation constrained the number of accessible testing locations and further contributed to the small sample size. Greater financial resources and manpower would be required to support mobile assessment teams, enabling in-home or community-based testing and facilitating the recruitment of a larger and more representative sample. Finally, the reliance on bulky, non-portable assessment equipment highlights a broader methodological limitation in community-based SCI research. Future studies would benefit from the development and validation of lightweight, portable, and user-friendly tools for assessing cardiorespiratory fitness. Such innovations would enhance feasibility, improve accessibility for individuals with mobility limitations, and support more inclusive and scalable community-based research among individuals with SCI in both urban and rural settings.

Implication of Findings

The findings of this study indicate that enhancing cardiorespiratory fitness and upper-limb strength may help individuals with spinal cord injury (SCI) perform daily activities more efficiently and maintain active participation in the community. However, physical activity engagement is influenced not only by physical capacity but also by broader social and environmental factors, including accessibility, transportation constraints, motivation, and the availability of support systems. These factors should be carefully considered when designing and implementing community-based rehabilitation programmes. The observed gender-related differences suggest that women with SCI may experience additional barriers to physical activity participation and may benefit from more targeted and inclusive support strategies. Furthermore, the logistical challenges of transporting large, non-portable assessment equipment underscore the need to develop portable, user-friendly tools for evaluating physical fitness in community settings. Given the high mobility demands and complex urban environment of the Klang Valley, larger-scale studies are warranted to better elucidate how physical fitness contributes to everyday functioning and to inform future rehabilitation planning and health policy development.

CONCLUSIONS

This study provides preliminary insights into the physical fitness and physical activity levels of community-dwelling individuals with SCI in the Klang Valley. Although limited by a small sample size, the findings indicate that higher cardiovascular fitness and upper-limb strength are associated with greater physical activity, suggesting that maintaining physical fitness may support greater independence and participation in daily life. The study also highlights the influence of social, environmental, and gender-related factors on physical activity engagement among individuals with SCI. These results underscore the importance of developing comprehensive community-based rehabilitation programs that address both physical conditioning and broader participation barriers. Future research with larger sample sizes, particularly in dense urban settings, is needed to confirm these relationships and guide the development of more accessible, effective, and inclusive rehabilitation strategies for individuals with SCI living in the community.

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Conflict Interest

No conflict of interest was reported for this study

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