North Clin Istanb 2026;13(1):28–35
doi: 10.14744/nci.2026.31855

Original Article RHEUMATOLOGY

Relationship between physical activity, daily step count, and posture in office workers and examination of DIERS pedoscan static plantar load distribution parameters: A cross sectional study

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ABSTRACT

OBJECTIVE: The aim of this study was to examine the relationship between physical activity level daily step count, and posture in office workers, and to investigate the associations of these variables with static plantar load distribution percentages across foot subregions.

METHODS: This cross-sectional study was conducted among office workers. Posture was evaluated using the New York Posture Rating Scale (NYPRS) by a single rater. Self-reported physical activity level was assessed using the International Physical Activity Questionnaire – Short Form (IPAQ-SF). Daily step counts were derived from pedometer records as the 7 day average and were collected via screenshots, application logs, or manual logs. Plantar static load distribution was measured using the DIERS pedoscan under barefoot conditions with a 20 second, 3 trial protocol. Normality was assessed using the Shapiro–Wilk test in conjunction with skewness and kurtosis values, and interpretation was guided by the ranges recommended by Tabachnick and Fidell.

RESULTS: A total of 39 office workers participated, with a mean age of 39.21±7.99 years and a mean body mass index (BMI) of 25.68±3.39 kg/m². Posture scores (NYPRS) were generally high, with the majority of participants classified in the "good" to "very good" category. There was a significant positive correlation between daily step count and NYPRS score ($r=0.360$, $p=0.024$). A significant positive association was also found between IPAQ and NYPRS ($r=0.364$, $p=0.023$). IPAQ and daily step count were moderately and significantly correlated ($r=0.549$, $p<0.001$). No statistically significant relationships were detected between static plantar load distribution percentages across foot subregions measured using the DIERS pedoscan system and NYPRS, IPAQ, daily step count, or BMI (all $p>0.05$).

CONCLUSION: In this sample, both daily step count and physical activity level assessed by IPAQ were positively associated with NYPRS posture scores. In contrast, DIERS pedoscan static regional load distribution parameters were not related to posture or activity indicators. These findings suggest that interventions aimed at increasing physical activity in office workers may be linked to posture, whereas static load distribution measurements may be limited in explaining these relationships.

Keywords: Office workers; physical activity; plantar pressure; postural balance; posture.

Cite this article as: *Erturk Celik G, Iskender A, Coskun Sagirkaya S, Doganci A. Relationship between physical activity, daily step count, and posture in office workers and examination of DIERS pedoscan static plantar load distribution parameters: A cross sectional study. North Clin Istanb 2026;13(1):28–35.*

Received: January 27, 2026 *Revised:* February 02, 2026 *Accepted:* February 15, 2026 *Online:* February 20, 2026

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Among office workers, prolonged sitting, computer based work, and low levels of physical activity are common lifestyle factors associated with musculoskeletal complaints, postural disorders, and reduced functional capacity. In this context, "posture" is not merely an aesthetic alignment but a functional parameter related to the coordinated alignment of the head, trunk, pelvis, and lower extremity segments, which influences musculoskeletal loading and movement efficiency [1–3].

Both clinical observational scales and technological measurement systems are used for posture assessment. The New York Posture Rating Scale (NYPRS) is a practical method frequently preferred in clinical practice because it systematically scores different body segments [4]. In addition, radiation free and contact free optical systems (e.g., DIERS formetric) have become increasingly widespread in spine and posture analysis, and studies have reported on their reproducibility and measurement reliability in evaluating scoliosis and postural asymmetries [4, 5].

Various approaches are used to examine the relationship between physical activity and posture. Self-report questionnaires such as IPAQ-SF are practical tools in large-scale surveys and have demonstrated acceptable reliability and validity in multiple countries and in the Turkish population; however, self-report measures are prone to recall bias and measurement error, and may differ from direct/objective measures [6–10]. In contrast, pedometer based daily step counts can provide a relatively objective indicator of daily mobility and may be useful for detecting low activity levels, particularly in office workers [11, 12].

Another dimension related to posture is load distribution during static standing. Measurements of plantar pressure/load distribution can provide information about postural strategies and potential asymmetries based on right–left or anterior–posterior loading differences. Systems such as DIERS pedoscan have found clinical application in the context of static and dynamic foot pressure analysis [13]. However, the relationship between static load distribution parameters and posture scales (e.g., NYPRS) and daily activity indicators (IPAQ, step count) may not be evident in every sample; for instance, a "ceiling effect" may be observed in populations with generally good posture levels [5].

This study aimed to examine the relationships among physical activity level assessed by the International Physical Activity Questionnaire–Short Form, daily step count obtained via a pedometer (7-day average), and posture as assessed by the New York Posture Rating Scale, as well as to investigate the associations of these variables with static plantar load distribution percentages across foot subregions (right and left forefoot and rearfoot) measured using the DIERS pedoscan system.

Highlight key points

- Higher daily step count is linked to better postural alignment in office workers.
- Self-reported physical activity (IPAQ) shows weak and inconsistent associations with posture.
- Static plantar load distribution is not significantly related to posture or activity in healthy adults.
- Increasing step count is a practical and monitorable target for workplace posture interventions.
- Mobility-promoting strategies may reduce musculoskeletal risks of prolonged sitting.

MATERIALS AND METHODS

This research was designed as a cross sectional observational study. It was conducted among office staff employed at a public institution between September and November 2025. Ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Ankara Bilkent City Hospital. Written informed consent was obtained from all participants prior to data collection. This study was conducted in accordance with the Declaration of Helsinki.

Participants

Eligible office workers who met the inclusion criteria and provided written informed consent were included in the study.

Inclusion criteria were as follows: office staff employed at a public institution who volunteered to participate in the study and spent at least 3 days per week, ≥3 hours per day in a seated, desk-based position performing computer-based or paperwork-related tasks. Participants with conditions that could affect posture, balance, mobility, or safe participation (cardiovascular, respiratory, neurological, vestibular, musculoskeletal, psychiatric disorders, pregnancy, or implanted electronic devices) were excluded from the study.

Measurement Tools and Procedures

Demographic and anthropometric measurements: Age, sex, educational level, and smoking status were recorded.

Height (cm) and weight (kg) were measured, and body mass index (BMI) was calculated as:

$$BMI = \frac{kg}{m^2}$$

Posture assessment (NYPRS): Posture was evaluated using the New York Posture Rating Scale (NYPRS). Higher total scores indicate better posture. All assessments were performed by a single rater [4].

Physical activity (IPAQ–Short Form): Physical activity level was assessed with the International Physical Activity Questionnaire – Short Form (IPAQ SF), and the total score was used in the analyses. IPAQ is a widely used self report tool in population based studies [6, 8, 9].

Daily step count (7-day pedometer average): Daily step counts were obtained from pedometer data. Information was collected through screenshots, application logs, or manual logs, and the daily step count was calculated as the mean of available valid days within a 7-day period. This approach was intended to reflect habitual daily mobility rather than peak physical activity levels [11, 12].

Static plantar load distribution (DIERS pedoscan): Static foot load distribution during quiet standing was measured using the DIERS pedoscan system under barefoot conditions, with each trial lasting 20 seconds and repeated three times [13]. The following DIERS pedoscan–derived static plantar load distribution percentages across foot subregions were included in the analyses: right forefoot, right rearfoot, left forefoot, and left rearfoot [14, 15].

Additional derived parameters, including anterior–posterior and right–left load distribution ratios, were calculated and reported descriptively to aid interpretation of the results and were not considered primary outcomes or subjected to extensive exploratory analyses.

Statistical Analysis

Statistical analysis were performed using SPSS Statistics version 27.0 (Armonk, New York: IBM Corp.). Descriptive statistics were reported as mean±SD, minimum–maximum, and percentages. Normality was evaluated using the Shapiro–Wilk test; given the sensitivity of this test in small samples, skewness and kurtosis values were also interpreted, and the approach recommended by Tabachnick and Fidell was taken into account [16].

For correlation analysis: Pearson correlation was used for variable pairs that were more compatible with normal distribution. Spearman rank correlation was used for variables with weaker normality assumptions (particularly IPAQ). The level of statistical significance was set at $p<0.05$. Correlation analyses were selected due to the exploratory nature of the study and the relatively small sample size. This approach was preferred to examine bivariate associations while avoiding potential overfitting and instability that may arise from multivariable modeling in small samples.

All statistical results reported in the Abstract, Results section, and tables were cross-checked using a single finalized SPSS output file to ensure internal consistency of correlation coefficients and p-values.

RESULTS

A total of 39 office workers were included in this cross sectional study. The sample was predominantly female (n=31, 79.5%), with a mean age of 32.64±6.36 years (range: 21–46 years; interquartile range [IQR]: 28–36 years). Educational status was undergraduate in 24 participants (61.5%) and postgraduate in 15 participants (38.5%). 12 participants (30.8%) were smokers and 27 (69.2%) were non smokers (Table 1). The mean body mass index (BMI) was 25.68±3.39 kg/m² (range: 20.1–35.7 kg/m²; IQR: 22.9–27.4 kg/m²) (Table 2). According to the WHO classification, no participants were underweight, whereas 16 participants (41.0%) had normal weight, 18 (46.2%) were overweight, and 5 (12.8%) were obese (Table 1). This distribution indicates that the sample primarily consisted of individuals in the normal to overweight range with relatively limited BMI variability.

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Table 1. Participant characteristics (n=39)

Variable	n	%
Sex		
Female	31	79.5
Male	8	20.5
Education		
Bachelor's degree	24	61.5
Postgraduate	15	38.5
Smoking		
Yes	12	30.8
No	27	69.2
WHO weight qualification		
Underweight	–	
Normal Weight	16	41.0
Overweight	18	46.2
Obese	5	12.8
NYPRS category		
Poor	2	5.1
Moderate	4	10.3
Good	11	28.2
Very good	22	56.4
Step count thresholds		
Sedentary	15	38.5
Low active	15	38.5
Somewhat active	3	7.7
Active	6	15.4
IPAQ classification		
Low physical activity	18	46.2
Moderate activity	16	41.0
High activity	5	12.8

NYPRS: New York Posture Rating Scale; IPAQ: International Physical Activity Questionnaire (Short Form).

Table 2. Descriptive statistics for continuous variables (n=39)

Variable	Mean±SD	Min–Max
Age (years)	39.21±7.99	26–53
Height (cm)	165.15±7.57	152.7–186.6
Weight (kg)	70.66±14.61	51.5–120.5
BMI (kg/m²)	25.68±3.39	20.1–35.7
Daily step count (steps/day)	5589.74±3619.89	1000–15000
IPAQ total (MET-min/week)	1122.72±1172.33	6.6–4479
NYPRS total score	49.82±6.71	33–63

SD: Standard deviation; BMI: Body mass index; IPAQ: International Physical Activity Questionnaire (Short Form); NYPRS: New York Posture Rating Scale.

Physical activity indicators showed considerable variability. The mean daily step count was 5589.74±3619.89 steps/day (range: 1000–15000; median: 5000; IQR: 3000–6500) (Table 2). When categorized according to established step count thresholds, 15 participants (38.5%) were classified as sedentary (<5000 steps/day), 15 (38.5%) as low active (5000–7499 steps/day), 3 (7.7%) as somewhat active (7500–9999 steps/day), and 6 (15.4%) as active (≥10000 steps/day) (Table 1). The International Physical Activity Questionnaire (IPAQ) total score averaged 1122.72±1172.33 MET min/week (range: 6.6–4479.0; IQR: 307.5–1729.5) (As shown in Table 2). Based on standard IPAQ classification, 18 participants (46.2%) reported low physical activity (<600 MET min/week), 16 (41.0%) reported moderate activity (600–2999 MET min/week), and 5 (12.8%) reported high activity (≥3000 MET min/week) (Table 1). These findings indicate that nearly half of the sample had low self reported physical activity levels, and a substantial proportion exhibited sedentary or low active step counts.

Static balance and weight distribution parameters measured using the DIERS pedoscan system demonstrated relatively symmetric patterns across the sample. The mean anterior weight distribution ratio was 0.396±0.078 (range: 0.26–0.60), whereas the posterior ratio was 0.604±0.078 (range: 0.40–0.74), indicating a physiological posterior weight bias during static standing. Lateral weight distribution showed a mean right side ratio of 0.511±0.053 (range: 0.40–0.64) and a left side ratio of 0.489±0.053 (range: 0.36–0.60), reflecting near symmetry between the two sides. Asymmetry indices, calculated as absolute differences, revealed a mean anterior–posterior asymmetry of 0.228±0.126 and a mean lateral asymmetry of 0.085±0.064 (Table 3). These values suggest that, on average, participants exhibited greater anterior–posterior than lateral differences in weight distribution, consistent with normal postural control patterns in healthy young adults.

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Table 3. Static plantar load distribution ratios

Variable	Mean±SD	Min–Max
Mean anterior weight distribution ratio	0.396±0.078	0.26–0.60
Mean posterior weight distribution ratio	0.604±0.078	0.40–0.74
Mean right side ratio	0.511±0.053	0.40–0.64
Meanleft side ratio	0.489±0.053	0.36–0.60
Mean anterior–posterior asymmetry	0.228±0.126	
Mean lateral asymmetry	0.085±0.064	

SD: Standard deviation.

ratio was 0.604±0.078 (range: 0.40–0.74), indicating a physiological posterior weight bias during static standing. Lateral weight distribution showed a mean right side ratio of 0.511±0.053 (range: 0.40–0.64) and a left side ratio of 0.489±0.053 (range: 0.36–0.60), reflecting near symmetry between the two sides. Asymmetry indices, calculated as absolute differences, revealed a mean anterior–posterior asymmetry of 0.228±0.126 and a mean lateral asymmetry of 0.085±0.064 (Table 3). These values suggest that, on average, participants exhibited greater anterior–posterior than lateral differences in weight distribution, consistent with normal postural control patterns in healthy young adults.

Body mass index showed no significant correlations with posture, daily step count, or IPAQ scores (all $p>0.05$). Specifically, BMI was not associated with NYPRS scores (Pearson $r=0.019$, $p=0.910$), daily step count (Pearson $r=0.067$, $p=0.687$), or IPAQ scores (Spearman $\rho=0.107$, $p=0.516$). This lack of association may reflect the relatively narrow BMI range and the predominantly normal to overweight composition of the sample, limiting the ability to detect BMI related effects on posture or physical activity.

Balance parameters measured by DIERS pedoscan did not demonstrate statistically significant correlations with NYPRS posture scores, daily step count, or IPAQ scores (Table 4). Anterior and posterior weight distribution ratios showed no significant associations with NYPRS (anterior: $r=-0.209$, $p=0.201$; posterior: $r=0.209$, $p=0.201$) or daily step count (anterior: $r=-0.093$, $p=0.574$; posterior: $r=0.093$, $p=0.574$). Similarly, right and left lateral weight distribution ratios were not significantly correlated with NYPD (right: $r=0.091$, $p=0.583$; left: $r=-0.091$, $p=0.583$) or with daily step count (right: $r=0.118$, $p=0.475$; left: $r=-0.118$, $p=0.475$). Asymmetry indices (anterior–posterior and lateral) also showed no significant correlations with NYPRS, daily step count, or IPAQ scores (all $p>0.05$). However, a borderline trend was observed between lateral asymmetry and IPAQ scores (Spearman $\rho=-0.273$, $p=0.092$), suggesting a possible inverse relationship that may warrant further investigation in larger samples (Table 5A, B).

Table 4. Main correlations (n=39)

Variable pair	Test	Coefficient	p
Daily step count – NYPRS	Pearson	$r=0.360$	0.024
IPAQ – NYPRS	Spearman	$\rho=0.364$	0.023
IPAQ – Daily step count	Spearman	$\rho=0.549$	<0.001

p-values <0.001 are reported as '<0.001'.

In summary, the primary finding of this study is the significant positive association between objectively measured daily step count and posture quality as assessed by the NYPRS scale. This relationship was not clearly observed with self reported physical activity (IPAQ), highlighting the potential advantage of objective activity monitoring in evaluating posture related behaviors. Although balance parameters exhibited expected physiological patterns, they were not significantly correlated with physical activity or posture measures in this relatively young and asymptomatic sample.

DISCUSSION

This study investigated the relationships among physical activity level, daily step count, body mass index (BMI), posture, and static balance parameters in office workers. Our findings showed that posture scores were generally within the good to very good range and that higher daily step counts were significantly associated with better posture scores. In contrast, no significant relationship was observed between self reported IPAQ scores and posture. This result suggests that, in office workers, step count may be a more practical and objective monitoring parameter than questionnaire based measures when tracking behavior related indicators associated with posture [7, 10–12].

Table 5. Correlations of pedoscan subregion ratios (n=39)

A) Pearson correlations: BMI / Steps / NYPRS vs. pedoscan ratios			
Pedoscan parameter	BMI r (p)	Daily steps r(p)	NYPD r (p)
Anterior		0.093 (0.574)	0.209 (0.201)
Posterior		0.093 (0.574)	0.209 (0.201)
Right lateral weight distribution ratios		0.118 (0.475)	0.091 (0.583)
Left lateral weight distribution ratios		0.118 (0.475)	0.091 (0.583)
NYPRS	0.019 (0.910)		
Daily steps	0.067 (0.687)		
B) Spearman correlations: IPAQ vs. Lateral asymmetry and BMI			
Variable pair	IPAQ ρ (p)		
Lateral asymmetry	0.273 (0.092)		
BMI	0.107 (0.516)		

BMI: Body mass index; IPAQ: International Physical Activity Questionnaire (Short Form); NYPRS: New York Posture Rating Scale.

Office work is a job model characterized by pronounced sedentary behavior and carries risks for musculoskeletal health [14]. Prolonged sitting, particularly in a "slumped" posture, may induce fatigue in trunk stabilizer muscles and negatively affect postural control; internal oblique and transversus abdominis muscle fatigue has been shown to increase with slumped sitting in office workers [3]. Changes in sitting posture affect head–neck alignment and muscle activity, and inappropriate sitting postures have been reported to increase loading on the neck and upper trunk muscles [15]. Accordingly, posture should not be addressed solely through generic "sit up straight" recommendations, but rather through comprehensive management of muscle function, motor control, muscle endurance, and daily behavior patterns [1, 2, 17, 18].

The positive association between daily step count and posture can be explained clinically through several potential mechanisms. Increased daily walking may interrupt sedentary time and reduce prolonged static loading on the spine and pelvis, thereby mitigating the tendency toward postural "collapse." Furthermore, increased movement may enhance circulation and promote more frequent activation of postural muscles, helping to preserve muscular endurance. Furthermore, increased movement may enhance circulation and promote more frequent activation of postural muscles, helping to preserve muscular endurance. Dynamic movement patterns, such as regular walking, may counteract the adverse effects of prolonged static sitting by promoting variability in spinal loading and muscle activation [14, 19].

Trunk muscle strength and endurance are critical for balance and functional performance, and insufficient trunk stabilization can impair lumbar control [18, 20]. These findings support the inclusion of trunk stabilization and endurance oriented exercises, in addition to stretching and positioning recommendations, in programs designed to preserve posture in office workers [1, 2, 21].

The absence of a significant association between IPAQ and posture is consistent with well known measurement discrepancies in the literature. In relatively homogeneous, office-based samples with generally low to moderate activity variability, self-reported instruments such as the IPAQ may have limited sensitivity to detect subtle differences in posture-related behaviors.

The validity of the IPAQ Short Form may vary across populations, and self reported physical activity measures are generally more prone to error than direct or objective measures [9, 10]. In contrast, pedometer derived step counts directly reflect daily mobility and may demonstrate more consistent relationships with health behaviors [11, 12]. Accordingly, our results indicate that daily step targets may be a useful and concrete means of operationalizing "increased physical activity" messages in clinical practice and workplace health programs [11, 12]. Moreover, postural alignment and control are influenced not only by activity levels but also by sensory inputs, particularly visu-

al information, which plays a critical role in head stabilization and postural regulation during upright activities [22].

Regarding static plantar load distribution, the largely symmetrical patterns observed and the lack of significant associations with physical activity indicators may be related to a ceiling effect due to the relatively young and functionally intact sample. In particular, the predominance of good-to-very-good posture classifications may have limited variability in posture scores, thereby reducing the ability to detect associations with static plantar load distribution parameters. Postural control is a multifactorial construct, and outcomes are highly dependent on the assessment method and test conditions [23].

Although the reliability of static plantar load and pressure measurements in healthy populations has been demonstrated, clinically meaningful differences may be less evident in asymptomatic samples [24]. In addition, lower extremity and foot–ankle components such as foot structure and plantar pressure distribution can affect postural stability; although the reliability of pedobarographic measurements has been demonstrated, more symptomatic or heterogeneous samples may be required for clinically meaningful differences to emerge [24–26]. From this perspective, incorporating dynamic balance tests and functional tasks may be beneficial for better capturing the posture–balance–activity relationship in office workers [23].

The absence of significant associations between BMI and posture or balance may similarly be explained by the limited BMI range of the sample, which was predominantly clustered in the normal–overweight categories. From a biomechanical standpoint, body weight and segmental alignment can influence postural loading; however, clinically observable effects often require a broader range of BMI values and/or higher symptom burden [1, 2, 27, 28]. Our findings suggest that, in young office workers, daily mobility/step count may be the behavioral indicator most closely related to posture [11, 12, 29].

From a clinical perspective, our results support targeting daily step count in preventive interventions for office workers. Interventions that reduce sedentary time and increase physical activity during the workday (e.g., scheduled short walking breaks, active work setups) are important in terms of feasibility and sustainability, and systematic reviews have emphasized the effectiveness of strategies to reduce sedentary behavior during productive work time [14]. Given that posture correction exercise programs have been reported to improve pain, combining step count targets with posture and exercise focused components may represent a practical strategy, particularly in workplace health and physical therapy settings [21].

This study has several limitations. The relatively small, single center sample may limit the generalizability of the findings. Due to its cross sectional design, causal relationships cannot be established; in addition to the possibility that higher step counts may improve posture, individuals with better posture may also be more likely to be physically active. The use of the self report IPAQ for physical activity assessment introduces susceptibility to measurement error and may partly explain the weaker associations compared with objective measures [6, 7, 10].

Posture was evaluated using a clinical scale, and no concurrent validation was performed with more detailed segmental alignment assessment methods such as surface topography/raster stereography; the literature indicates that different posture measurement techniques vary in reliability and sensitivity [4, 5, 27, 28]. Balance assessment was conducted under static conditions using DIERS pedoscan, and no dynamic balance or functional tests were included; postural function is known to be sensitive to test methods and task conditions [23].

Additionally, the relatively young and mostly asymptomatic sample may have contributed to a ceiling effect in balance parameters, making it more difficult to detect associations.

This study suggests that, among office workers, daily step count may be associated with better posture, whereas self reported physical activity level measured by IPAQ was not clearly associated with posture. These findings may indicate that daily step count could serve as a practical, objective, and monitorable indicator of habitual physical activity in workplace based approaches aimed at supporting postural health [11, 12, 14]. However, given the cross-sectional design, the relatively small sample size, and the absence of a formal a priori power analysis, these findings should be interpreted cautiously and primarily considered exploratory.

Future research should incorporate longitudinal or intervention-based designs to better clarify the temporal and causal relationships between daily step count, posture, and balance. In addition, the inclusion of dynamic balance assessments and functional tasks, rather than relying solely on static plantar load distribution measures, may provide greater sensitivity in detecting posture–activity–balance interactions, particularly in office-based populations [14].

Ethics Committee Approval: The Ankara Bilkent City Hospital Medical Research Scientific and Ethical Review Board approval for this study (date: 24.09.2025, number: TABED-1-25-1721).

Informed Consent: Written informed consent was obtained from all subjects involved in the study.

Conflict of Interest: The authors declare that there is no conflict of interest.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: The authors used AI-assisted language editing tools solely for improving grammar and language clarity. All scientific content, analysis, and conclusions were developed by the authors.

Authorship Contributions: Concept – GEC; Design – GEC, AI; Supervision – GEC; Materials – GEC, AI, SCS, AD; Data collection and/or processing – GEC, AI; Analysis and/or interpretation – AI, GEC; Literature search – GEC, AI, SCS, AD; Writing – GEC, AI, SCS, AD; Critical review – GEC, AI.

Peer-review: Externally peer-reviewed.

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