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Title:
Relationship Between Waist Circumference and Trunk Fat Percentage in People with Physical Disabilities

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Abstract

While mortality due to spinal cord injuries (SCI) and urinary tract infections has markedly decreased, the incidence of malignant tumors and lifestyle-related diseases is increasing among people with physical disabilities. However, regular assessment of body weight and composition remains challenging in this population. This cross-sectional study aimed to clarify the relationship between waist circumference, trunk fat percentage, and visceral fat level, with a particular focus on waist circumference as an easily measurable indicator. A total of 151 individuals participated, including 42 with SCI, 42 with cerebrovascular disease (CVD), and 67 without disabilities. Waist circumference, trunk fat percentage, and visceral fat level were measured in sitting and supine positions for all participants, and in the standing position for those without disabilities. Position-related differences were analyzed, with statistical significance set at 5%. Waist circumference varied by measurement position, with the highest values observed in the sitting position. For participants with SCI, the average waist circumference was 90.9±13.1 cm in the sitting position and 81.6±10.9 cm in the supine position. In participants with CVD, the respective values were 93.4±9.8 cm and 86.5±8.5 cm. Waist circumference showed significant positive correlations with both trunk fat percentage and visceral fat level. Standard screening values may underestimate adiposity in people with physical disabilities. These findings suggest the necessity of adopting specific reference values and support the utility of waist circumference measurements taken in the sitting and supine positions in this population.

Key words:

Waist Circumference; People with Physical Disabilities; Trunk Fat Percentage; Visceral Fat; Lifestyle-Related Disease

タイトル：肢体不自由者のウエスト周囲長と体幹部脂肪率の関係

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要旨：

目的：本研究の目的は、立位保持が困難である肢体不自由者において、測定姿勢によるウエスト周囲長の違いを検証し、ウエスト周囲長と体幹部脂肪率および内臓脂肪レベルの関係性を明らかにすることとした。

対象：対象は脊髄損傷者 42 名、脳血管障害者 42 名、健常者 67 名とした。

方法：ウエスト周囲長の測定は、座位および背臥位で全対象者に実施し、さらに健常者に対しては立位での測定も実施した。ウエスト周囲長測定の再現性は級内相関係数にて確認した。加えて、体幹部脂肪率・内臓脂肪レベルを測定した（タニタ腹部脂肪計　AB-140）。ウエスト周囲長と体幹部脂肪率の関係については、単回帰分析を行い、回帰式を求めた。得られた回帰式を用いて、男性の体幹部脂肪率上限値(27%)に相当するウエスト周囲長を算出した。ウエスト周囲長と内臓脂肪レベルの関係については相関分析を行った。

結果：ウエスト周囲長は測定姿勢によって異なる値を示した。脊髄損傷者のウエスト周囲長平均値(SD)は、座位：90.9(13.1)cm、背臥位：81.6(10.9)cm、脳血管障害者は座位：93.4(9.8)cm、背臥位：86.5(8.5)cm であった。ウエスト周囲長測定の級内相関係数は 0.99 と高い値を示した。ウエスト周囲長と体幹部脂肪率の関係から算出したウエスト周囲長は脊髄損傷者・座位：75.0cm、背臥位：72.8cm、脳血管障害者・座位：69.2cm、背臥位：69.1cm、健常者・座位：95.6cm、背臥位：89.2cm、立位 92.7cm であった。また、内臓脂肪レベルは、ウエスト周囲長が増加するに従って高値を示した。

考察：ウエスト周囲長は測定姿勢により異なる値を示し、特に座位では股関節および脊柱の屈曲により腹部の軟部組織が凝集するため、高値となると考えた。体幹部脂肪率 27%に相当するウエスト周囲長は、脊髄損傷者および脳血管障害者においては、特定健診・特定保健指導の基準値（男性 85cm）を下回っていた。一方、健常者ではいずれの測定姿勢においても 85cm を上回っていた。したがって、特定健診・特定保健指導のウエスト周囲長の基準値は、肢体不自由者の体幹部脂肪率および内臓脂肪レベルを反映していないと考えた。座位および背臥位で測定したウエスト周囲長は、体幹部脂肪率と内臓脂肪レベルを反映したものであり、再現性も高く、立位保持が困難である肢体不自由者にとって有効な手法であると言える。

結論：特定健診・特定保健指導に用いられている基準値を立位保持が困難な肢体不自由者に適用することはできない。座位および背臥位でのウエスト周囲長測定は肢体不自由者にとって有効な手段であり、日常的に体幹部脂肪率と内臓脂肪レベルを推定する手段として有効である。

Introduction

According to the US Spinal Cord Injury Patient Database, individuals with spinal cord injuries (SCI) are living longer due to advancements and implementation of medical care. A previous report indicated that renal failure and urinary tract infections, once leading causes of death among patients with SCI, have significantly decreased. Consequently, the causes of death have been shifting over time[1].

In Japan, uniform data on long-term outcomes or causes of death in individuals with SCI are lacking; however, analyses of databases from laborers' hospitals have been conducted. These reports show that while deaths due to SCI-related complications, renal failure, and infections have declined, the prevalence of malignant tumors and lifestyle-related diseases has increased[2-4].

Lifestyle-related diseases are also strongly associated with cerebrovascular disease (CVD), which is common in individuals with hemiplegia[5]. In Japan, the Specific Health Checkups and Specific Health Guidance (SHCSHG) program was launched in 2008 to help prevent such diseases[6]. This program also includes individuals with disabilities. It assesses risk factors such as waist circumference, blood pressure, and blood glucose levels, and provides guidance to those at risk. Waist circumference and body mass index (BMI) are used as screening tools[7]. However, standard BMI values are not appropriate for individuals with physical disabilities, who often exhibit reduced skeletal muscle mass or motor impairment[8]. While waist circumference reflects visceral fat mass, the SHCSHG requires measurements to be taken at the level of the navel in the standing position. This method may be impractical or unfeasible for individuals with physical disabilities[9].

Moreover, the standard cut-off values for waist circumference in the SHCSHG are 85 cm for men and 90 cm for women. The validity of these thresholds in non-standing positions remains unclear. Applying standing-based reference values to individuals unable to stand may be inappropriate. Furthermore, most commercially available body composition analyzers require users to stand barefoot and hold electrodes. Individuals wearing orthoses or prostheses may not be able to undergo measurement using bioelectrical impedance analysis. As a result, many individuals with physical disabilities face significant challenges in assessing body composition regularly.

Therefore, it is problematic to detect lifestyle-related diseases in this population using the SHCSHG or commercial analyzers. In this study, we focused on waist circumference—a parameter that can be measured easily by caregivers or family members in a non-standing position. By clarifying the relationships among waist circumference, visceral fat level, and trunk fat percentage in non-standing postures, we aim to enable simple, daily monitoring of visceral fat. This may support the prevention and management of lifestyle-related diseases. The purpose of this study was twofold: (1) to evaluate differences in waist circumference based on measurement position, and (2) to investigate the relationships between waist circumference, trunk fat percentage, and visceral fat level in individuals with physical disabilities who have difficulty standing.

Materials and Methods

Study Design

This was a cross-sectional study. The required sample size was calculated using power analysis in R version 2.8.1 (CRAN). Participants were recruited at the implementing research institution between 2018 and 2020.

Participants

The participants included males with spinal cord injury (SCI), males with cerebrovascular disease (CVD) caused by trauma or disease, and males without physical disabilities. Individuals with physical disabilities were ineligible for commercially available body composition analyzers due to difficulty standing or the use of orthoses or prostheses. To avoid fluctuations in body composition following acute onset or injury, only participants for whom at least six months had passed since onset were included.

A total of 151 participants were enrolled: 42 with SCI, 42 with CVD, and 67 without physical disabilities. The mean (range) ages were as follows: SCI group, 40.3 years (20–77); CVD group, 58.3 years (27–83); control group, 39.7 years (21–61). Individuals with pacemakers, intrathecal baclofen pumps, or other implantable devices were excluded. Participant characteristics are shown in Table 1. Insert Table 1 here

The study was approved by the Institutional Review Board of Tokyo Metropolitan University, Arakawa Campus (Approval No. 18077); the Ethics Committee of the Kawakita Medical Foundation (Approval No. H2018-0023); the Ethics Committee of the Saitama Rehabilitation Center (Approval No. H30-012); and the Ethics Committee of the Sonoda Medical Corporation (Approval No. 94). Additional approval was obtained from Kanagawa Rehabilitation Hospital, the Tokyo Metropolitan Sports Center for Persons with

Disabilities, and the Yokohama Rapport Sports & Culture Center. All participants provided written informed consent prior to study participation.

Outcome Measures

Measurement of Waist Circumference

Waist circumference was measured in the sitting and supine positions for all participants, and in the standing position for participants without physical disabilities. The measurement site was the level of the navel. Measurements were taken at the end of normal exhalation using a flexible tape placed horizontally and without compressing the abdominal wall. All measurements were performed at least two hours after a meal to avoid postprandial variability. Each measurement was repeated three times, and the mean value was calculated (Insert Figure 1 here).

To minimize the influence of muscle tone or compensatory activity to maintain posture, participants were measured in as relaxed a state as possible. For regular wheelchair users, measurements were taken with the participant leaning against the backrest, feet resting on the foot supports, and arms relaxed at the sides. For non-regular wheelchair users, participants were seated in a standard chair with a backrest, feet placed flat on the floor (Figure 1A). In the supine position, participants lay on a large bed in a relaxed posture, with arms placed comfortably at the sides when possible. When necessary, pillows were used to reduce discomfort or accommodate increased muscle tone, pain, or deformity (Figure 1B). All measurements were performed by licensed physiotherapists. Intra-rater reliability was assessed using the intraclass correlation coefficient (ICC 1.1).

Measurement of Trunk Fat Percentage and Visceral Fat Level

Trunk fat percentage and visceral fat level were assessed using the AB-140 Abdominal Fat Meter (Tanita Corp., Tokyo, Japan). Insert Figure 2 here This device consists of a curved sensor unit and a belt-type impedance meter (Figure 2). The sensor was applied at the level of the navel, and impedance values were used to calculate trunk fat percentage and visceral fat level.

Trunk fat percentage was defined as the sum of visceral and subcutaneous fat in the trunk. In healthy males, trunk fat percentage measured using this device typically ranges from 13.9% to 27.0%, as reported by Nagano et al[10]. Although values exceeding 27% are observed in individuals with excess adiposity, the 27% threshold is commonly used as an upper reference limit for healthy populations. This cutoff has been proposed as a practical benchmark for identifying abdominal obesity associated with increased metabolic risk. Furthermore, Browning et al. validated the use of this device by demonstrating a strong correlation between trunk fat percentage and MRI-derived total abdominal adipose tissue[11]. Previous studies have demonstrated that bioelectrical impedance analysis (BIA) provides comparable accuracy to dual-energy X-ray absorptiometry (DXA)[12] in estimating regional body composition. In individuals with SCI, trunk fat percentage measured with this abdominal fat meter has shown a strong correlation with DXA-based measurements[13].

Visceral fat level is a calculated index corresponding to visceral fat area. Specifically, a visceral fat level of 1.0 and 10.0 reflects approximately 10 cm^2 and 100 cm^2 of visceral fat area, respectively. This relationship has been validated against measurements obtained via computed tomography (CT)[14].

Statistical Analysis

For individuals with physical disabilities, waist circumference measurements in the sitting and supine positions were compared using the paired t-test. In participants without physical disabilities, comparisons among the sitting, supine, and standing positions were performed using repeated-measures ANOVA.

To evaluate the association between waist circumference and trunk fat percentage, simple linear regression analysis was used. Waist circumference was the independent variable and trunk fat percentage was the dependent variable. Based on the regression equation, the waist circumference corresponding to a trunk fat percentage of 27%—considered the upper limit for average males—was estimated.

The association between waist circumference and visceral fat level was examined using Pearson's correlation coefficient. In the SCI group, comparisons were additionally conducted between individuals with and without abdominal muscle contraction. Normality of all variables was assessed using the Shapiro–Wilk test. The significance level was set at 5%. All statistical analyses were performed using R version 2.8.1 (CRAN).

Results

Reproducibility of Waist Circumference Measurements

The intra-rater reliability of waist circumference measurements, assessed using ICC (1.1), demonstrated a high value of 0.99 across all measurement conditions.

Comparison of Waist Circumference by Position (Table 2) Insert Table 2 here

Individuals with Spinal Cord Injury (SCI)

The mean (± SD) waist circumference in individuals with SCI (n = 42) was 90.9 ± 13.1 cm in the sitting position and 81.6 ± 10.9 cm in the supine position. The Wilcoxon signed-rank test indicated that waist circumference was significantly greater in the sitting position than in the supine position.

In participants with abdominal muscle contraction (n = 27), the mean waist circumference was 89.4 ± 12.8 cm (sitting) and 81.5 ± 10.8 cm (supine). In those without abdominal muscle contraction (n = 15), the respective values were 93.4 ± 13.6 cm (sitting) and 81.6 ± 11.6 cm (supine). Paired t-tests confirmed that waist circumference was significantly greater in the sitting position for both subgroups.

Individuals with Cerebrovascular Disease (CVD)

In individuals with CVD (n = 42), the mean waist circumference was 93.4 ± 9.8 cm in the sitting position and 86.5 ± 8.5 cm in the supine position. Paired t-test analysis showed that waist circumference was significantly greater in the sitting position.

Individuals without Physical Disabilities

In individuals without physical disabilities (n = 67), the mean waist circumference was 84.2 ± 7.1 cm in the sitting position, 79.3 ± 6.7 cm in the supine position, and 82.2 ± 6.3 cm in the standing position. Repeated-measures ANOVA revealed a significant effect of position, with waist circumference being greatest in the sitting position.

Relationship Between Waist Circumference and Trunk Fat Percentage

Individuals with Spinal Cord Injury (SCI)

Simple linear regression analysis was used to assess the relationship between waist circumference (X) and trunk fat percentage (Y) in individuals with SCI. The resulting regression equations were as follows:

All SCI (Figure 3A):

- Sitting position: $Y = -26.5 + 0.55X$ ($R^2 = 0.75$, $P < 0.01$)
- Supine position: $Y = -30.3 + 0.66X$ ($R^2 = 0.75$, $P < 0.01$)

SCI with abdominal muscle contraction (Figure 4A):

- Sitting position: $Y = -32.1 + 0.62X$ ($R^2 = 0.79$, $P < 0.01$)
- Supine position: $Y = -36.4 + 0.73X$ ($R^2 = 0.79$, $P < 0.01$)

SCI without abdominal muscle contraction (Figure 4B):

- Sitting position: $Y = -17.5 + 0.45X$ ($R^2 = 0.70$, $P < 0.01$)
- Supine position: $Y = -20.1 + 0.55X$ ($R^2 = 0.75$, $P < 0.01$)

Individuals with Cerebrovascular Disease (CVD) (Figure 3B):

- Sitting position: $Y = -22.3 + 0.53X$ ($R^2 = 0.61$, $P < 0.01$)
- Supine position: $Y = -25.7 + 0.61X$ ($R^2 = 0.61$, $P < 0.01$)

Insert Figure 3 here, Insert Figure 4 here

Individuals without physical disabilities

- Sitting position: $Y = -31.4 + 0.61X$ ($R^2 = 0.77$, $P < 0.01$)
- Supine position: $Y = -35.7 + 0.70X$ ($R^2 = 0.80$, $P < 0.01$)
- Standing position: $Y = -35.1 + 0.67X$ ($R^2 = 0.79$, $P < 0.01$)

Waist Circumference Corresponding to the Upper Limit (27%) of Trunk Fat Percentage

Using the regression equations, waist circumference values corresponding to a trunk fat percentage of 27%—the upper limit for healthy males—were estimated:

Sitting position:

- All SCI: 75.0 cm
- SCI with abdominal muscle contraction: 79.1 cm
- SCI without abdominal muscle contraction: 65.6 cm
- CVD: 69.2 cm
- Individuals without physical disabilities: 95.6 cm

Supine position:

- All SCI: 72.8 cm
- SCI with abdominal muscle contraction: 77.0 cm
- SCI without abdominal muscle contraction: 63.5 cm
- CVD: 69.1 cm
- Individuals without physical disabilities: 89.2 cm

Standing position

- Individuals without physical disabilities: 92.7 cm

Relationship Between Waist Circumference and Visceral Fat Level

Individuals with SCI

The relationship between waist circumference and visceral fat level was analyzed using correlation coefficients. In the SCI group, Spearman's rank correlation was applied to sitting measurements, and Pearson's correlation to supine measurements.

All SCI:

• Sitting position: r = 0.81, $P < 0.01$

• Supine position: r = 0.79, $P < 0.01$

Subgroup analysis based on abdominal muscle contraction yielded the following:

With abdominal muscle contraction:

• Sitting position: r = 0.81, $P < 0.01$

• Supine position: r = 0.79, $P < 0.01$

Without abdominal muscle contraction:

• Sitting position: r = 0.66, $P < 0.01$

• Supine position: r = 0.70, $P < 0.01$

Individuals with CVD

Pearson's correlation analysis showed that visceral fat level was positively correlated with waist circumference in both sitting and supine positions:

• Sitting position: r = 0.54, $P < 0.001$

• Supine position: r = 0.57, $P < 0.01$

Discussion

Difference in Waist Circumference by Measurement Position

Waist circumference varied depending on the measurement position in individuals with and without physical disabilities, including those with SCI and CVD. Among all groups, measurements taken in the sitting position yielded the highest values. This increase may be attributed to flexion at the hip and spine, which causes abdominal soft tissue to accumulate anteriorly. Moreover, the sitting posture, being an anti-gravity position, may facilitate the downward displacement of internal organs, contributing to an increased waist circumference.

Previous studies have suggested that a decrease in lumbar lordosis and posterior pelvic tilt—often seen in individuals with reduced trunk function—may lead to organ prolapse*15,16*. It is likely that a diminished capacity to support the position of internal organs results in downward migration, thereby influencing waist circumference measurements.

Relationships Among Waist Circumference, Trunk Fat Percentage, and Visceral Fat Levels

Waist circumference values corresponding to the upper limit (27%) of male trunk fat percentage were higher in the sitting position than in the supine position. Notably, these values were lower than the SHCSHG standard cut-off of 85 cm for men. This finding suggests that the standard reference values for waist circumference may not accurately reflect trunk fat percentage or visceral fat level in individuals with physical disabilities. Consequently, there is a risk of underestimating obesity-related indicators in this population.

The waist circumference among individuals with SCI differed by 13.5 cm depending on the presence or absence of abdominal muscle contraction. This observation suggests that abdominal muscle activity may influence fat accumulation in the trunk. Prior studies have reported that individuals with SCI tend to have higher body fat percentages and accumulate fat in paralyzed regions compared to healthy individuals*17-20*. These findings imply that trunk fat accumulation may differ based on the ability to contract abdominal muscles, which should be considered when establishing reference values for waist circumference. In contrast, individuals with CVD often retain more trunk function, which may influence their trunk fat percentage and visceral fat level. Future studies should further investigate the association between trunk function and fat accumulation severity.

Waist Circumference Measurement Methods in Individuals with Physical Disabilities

Waist circumference varied with posture in all groups, with the highest values consistently observed in the sitting position. Therefore, applying standing-based reference values such as those used in SHCSHG may be inappropriate for individuals who cannot maintain a standing posture. However, waist circumference measurements in the sitting and supine positions demonstrated high reproducibility and may serve as valid and practical alternatives for this population.

Significance for Physical Therapy

We clarified how waist circumference measured in the sitting and supine positions is associated with trunk fat percentage and visceral fat level in individuals with physical disabilities who are unable to stand.

This finding provides physical therapists with a practical and accessible method to assess obesity-related health risks in individuals who have difficulty maintaining a standing posture. In the prevention and management of lifestyle-related diseases, physical therapists play a central role in prescribing and supervising exercise interventions. However, in order to determine who requires intervention and whether the intervention is effective, simple and reliable assessment tools are essential—especially for individuals with mobility limitations.

Measuring waist circumference in the sitting or supine position allows for the estimation of trunk fat and visceral fat levels without requiring standing posture or advanced equipment. This method supports clinical decision-making, such as initiating or modifying exercise programs, and allows for longitudinal monitoring. Moreover, because this measurement can be performed at home, it encourages patient engagement in self-monitoring and supports shared decision-making between patients and therapists. Ultimately, this approach may contribute to the prevention of disease onset and recurrence.

Limitations of This Study

Waist circumference may be influenced by variations in sitting posture, making it necessary to perform measurements under standardized conditions. In this study, waist circumference was measured under conditions intended to reflect routine daily measurement settings. Participants were seated against the backrest, with their upper limbs relaxed at their sides. However, it was difficult to maintain consistent pelvic tilt and load distribution across the seat and backrest. Future studies should establish objective indices to quantify sitting posture and improve the consistency of measurement conditions.

Additionally, there were age differences among the study groups (SCI: mean 40.3 years, CVD: 58.3 years, individuals without physical disabilities: 39.7 years). Because age may influence body fat distribution and visceral fat accumulation, future studies should include age as a covariate in statistical models to adjust for its potential effects.

Conclusions

In individuals with physical disabilities who have difficulty in standing, waist circumference measured in the sitting position was greater than that measured in the supine position. Regression analyses demonstrated a relationship between waist circumference and trunk fat percentage in both positions. These findings suggest that standard waist circumference values used in the SHCSHG are not applicable to individuals who cannot stand. New reference values should be established based on the specific characteristics of this population.

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Conflicts of Interest

The authors declare no conflicts of interest related to this work.

Contributions

MS conceptualized and designed the study. YF contributed to data analysis and interpretation. MS drafted the manuscript. All authors reviewed and approved the final version of the manuscript.

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Figure Legends

Figure1 Measurement of waist circumference

A Measurement of in the sitting position; B Measurement of in the supine position

Figure2 The Abdominal Fat Meter

Left; Curved body, Right; Belt-type impedance meter

Figure 3. Relationship between waist circumference and trunk fat percentage in each position.

(A) Individuals with spinal cord injury (SCI): sitting, $y = –26.5 + 0.55x$ ($R^2 = 0.75$); supine, $y = –30.3 + 0.66x$ ($R^2 = 0.75$).

(B) Individuals with cerebrovascular disease (CVD): sitting, $y = –22.3 + 0.53x$ ($R^2 = 0.61$); supine, $y = –25.7 + 0.61x$ ($R^2 = 0.61$)

Figure 4. Relationship between waist circumference and trunk fat percentage in individuals with spinal cord injury, classified by abdominal muscle contraction.

(A) With abdominal muscle contraction: sitting, $y = –32.1 + 0.62x$ ($R^2 = 0.79$); supine, $y = –36.4 + 0.73x$ ($R^2 = 0.79$).

(B) Without abdominal muscle contraction: sitting, $y = –17.5 + 0.45x$ ($R^2 = 0.70$); supine, $y = –20.1 + 0.55x$ ($R^2 = 0.75$).

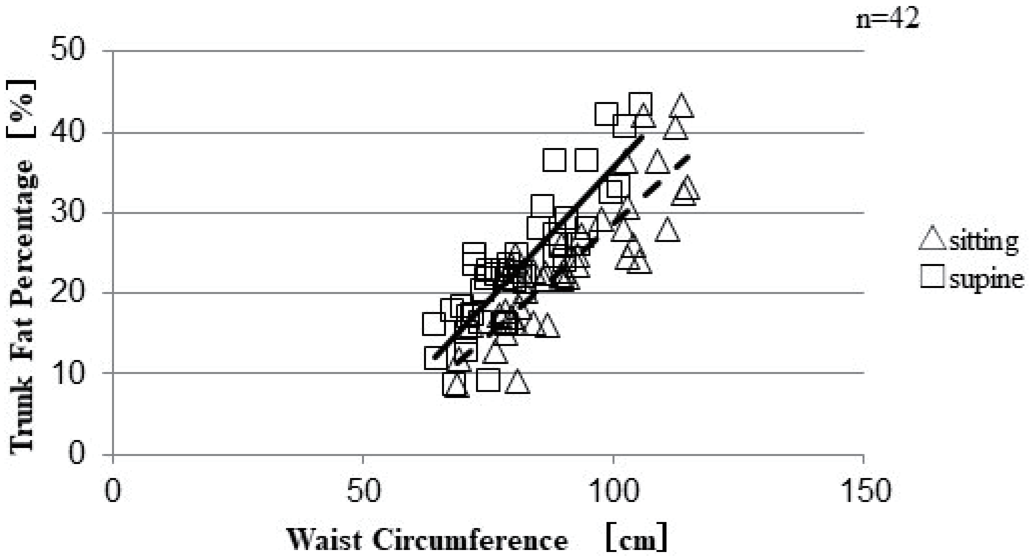

A
B
PACKWARMER

Body

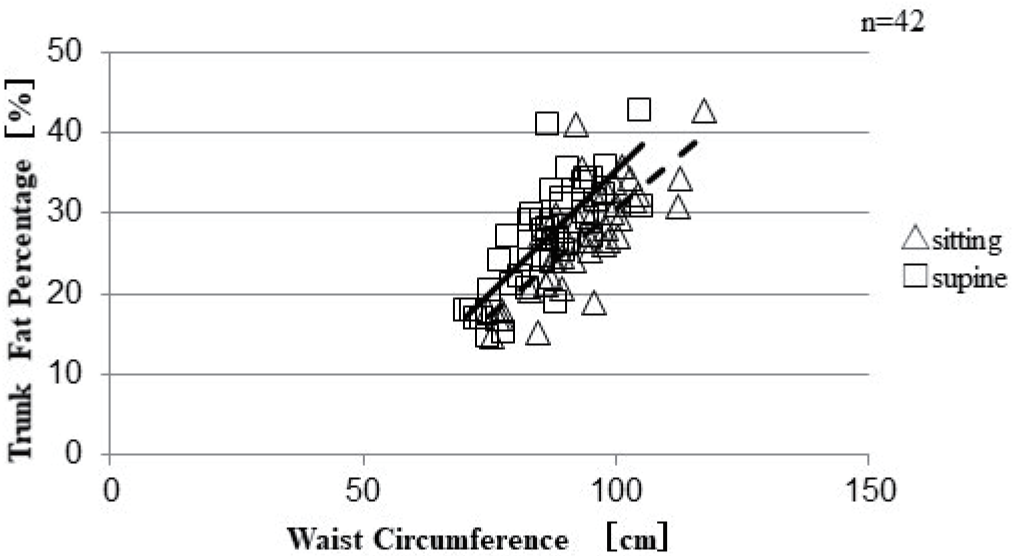
Impedance meter (Front)

Impedance meter (Back)

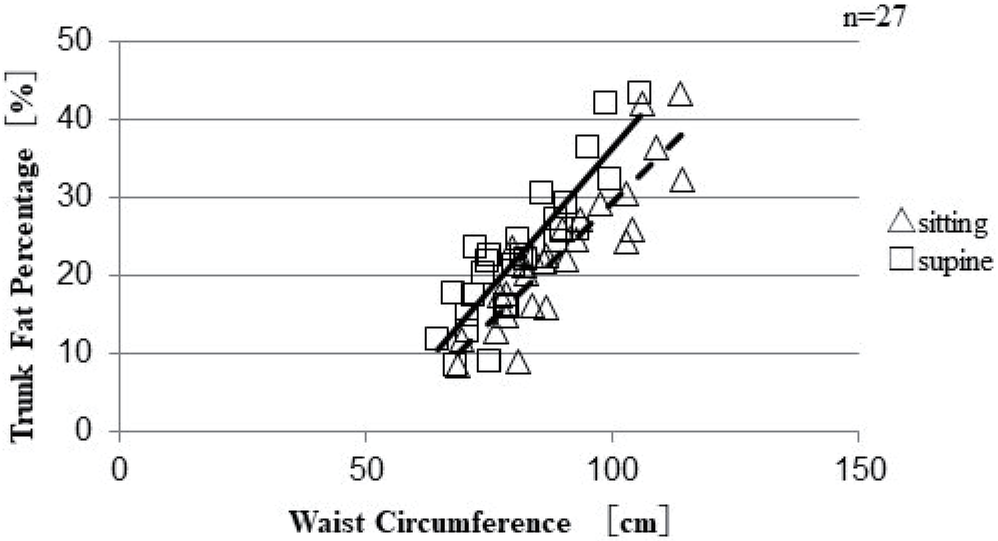
A


n=42
50
40
30
20
10
0
Trunk Fat Percentage [%]
0
50
100
150
Waist Circumference [cm]
sitting
supine

B

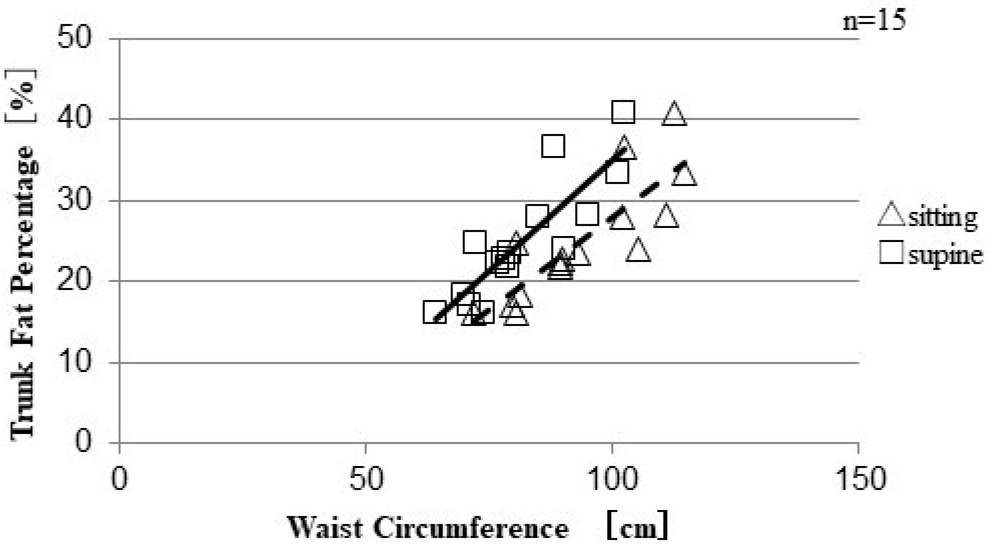

n=42
50
40
30
20
10
0
Trunk Fat Percentage [%]
0
50
100
150
Waist Circumference [cm]
sitting
supine

A



n=27
Trunk Fat Percentage [%]
0
10
20
30
40
50
Waist Circumference [cm]
0
50
100
150
△sitting
□supine

B



n=15
Trunk Fat Percentage [%]
0
10
20
30
40
50
Waist Circumference [cm]
0
50
100
150
△sitting
□supine

Table 1. Participants characteristics

	SCI (*n*=42)			
	With abdominal muscle contraction (*n*=27)	**Without abdominal muscle contraction (*n*=15)**	**CVD (*n*=42)**	**People without physical disabilities (*n*=67)**
Age at enrollment (y) Mean (range)	40.3 (20–77)		58.3 (27–83)	39.7 (21–61)
	48.3 (20–77)	50.9 (23–72)		
Time since accident (y) Mean ± SD	19.4±21.2		6.9±7.5	-
	19.6±23.3	19.1±17.3		
Traumatic SCI	18	13	-	-
Spinal cord disease[a]	9	2	-	-
Cerebral infarction	-	-	16	-
Cerebral hemorrhage	-	-	22	-
Subarachnoid hemorrhage	-	-	1	-
Others[b]	-	-	3	-
Quadriplegia	9	12	2	-
Paraplegia	18	3	0	-
Hemiplegia (right)	-	-	17	-
Hemiplegia (left)	-	-	23	-

[a]Spinal cord disease includes spinal bifida, polio, spinal caries, myelitis, ossification of the posterior longitudinal ligament, and paraplegia due to aorta dissection.

[b]Others include trauma and subdural hematoma.

SCI: spinal cord injury; CVD: cerebrovascular disease.

Table 2. Comparison of waist circumference by position

	sitting	supine	standing	
SCI (n=42)	90.9 (13.1)	81.6 (10.9)	-	**
with abdominal muscle contraction (n=27)	89.4 (12.8)	81.5 (10.8)	-	**
without abdominal muscle contraction (n=15)	93.4 (13.6)	81.6 (11.6)	-	**
CVD (n=42)	93.4 (9.8)	86.5 (8.5)	-	**
Individuals without physical disabilities (n=67)	84.2 (7.1)	82.2 (6.3)	79.3 (6.7)	*

Values are expressed as group mean (SD).

SCI: spinal cord injury,CVD: cerebrovascular disease

* $P < 0.05$, ** $P < 0.01$