Section: Critical Care Medicine

Original Research Article

HANDGRIP STRENGTH ACROSS OCCUPATIONAL GROUPS IN A TERTIARY-CARE HOSPITAL WORKFORCE: A SEX-STRATIFIED CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Handgrip strength (HGS) is a practical measure of muscle function, but interpretation depends strongly on sex, age, body size and population context. Previous analyses that pool men and women or apply geriatric thresholds to younger workers may be misleading. We therefore re-examined HGS as a sex-stratified occupational profile and used Asian Working Group for Sarcopenia (AWGS) 2025 thresholds only in the age range for which they are defined.

Materials and Methods: This cross-sectional analysis included 445 employees from a tertiary-care hospital workforce dataset after duplicate removal and complete-case selection. Because handedness was not documented, right-versus-left comparisons were not made; the higher of the two recorded handgrip values was used as maximum HGS. Occupational categories were standardized without broad post-hoc clustering. Occupation-specific comparisons were restricted to categories with at least 10 participants and were reported separately for women and men. A linear model evaluated occupation in relation to HGS while adjusting for age, sex and BMI. AWGS 2025 HGS thresholds were examined only among participants aged 50–64 years.

Results: The sample comprised 279 women and 166 men (mean age 34.0 ± 10.2 years). Mean maximum HGS was 18.1 ± 4.6 kg in women and 30.5 ± 8.9 kg in men. Raw HGS differed across occupations, but age and sex distributions also varied substantially between occupational groups. In the adjusted model restricted to occupations with n≥10, no occupation differed significantly from nursing after adjustment for age, sex and BMI. Age was associated with lower HGS (−0.15 kg/year, 95% CI −0.24 to −0.07), male sex with higher HGS (+13.81 kg, 95% CI 12.00 to 15.63), and BMI with higher HGS (+0.34 kg per kg/m², 95% CI 0.17 to 0.51). Among 55 participants aged 50–60 years, 44 (80.0%) were below the AWGS 2025 age-specific HGS reference threshold; no participant was aged ≥65 years.

Conclusions: HGS differs markedly by sex and age within a hospital workforce, and unadjusted occupational comparisons are strongly influenced by workforce composition. After adjustment for age, sex and BMI, clear occupation-specific differences were not demonstrated. AWGS 2025 thresholds should be used only as an age-appropriate secondary reference in this cohort and cannot establish sarcopenia without muscle-mass assessment.

Keywords: handgrip strength; healthcare workers; occupational health; workforce; muscle strength; cross-sectional study.

INTRODUCTION

Handgrip strength (HGS) is a simple and reproducible measure of muscle function and has been used in epidemiological, clinical and healthy-ageing research. Lower HGS has been associated with adverse outcomes in many populations, but its interpretation is highly dependent on sex, age, body size, measurement protocol and population context.[1-3]

Healthcare institutions include occupational groups with markedly different demographic profiles and physical work demands. Nurses, doctors, technicians, administrative personnel, housekeeping staff and security staff differ in age distribution, sex composition, work posture, manual workload and shift patterns. Consequently, crude comparison of mean HGS between occupations may be confounded by workforce composition and should not be interpreted without sex-stratified description and appropriate adjustment.

The AWGS 2025 consensus has moved from an exclusively older-adult sarcopenia framework toward a life-course muscle-health approach and introduced age-specific thresholds for adults aged 50–64 years. For HGS, the 2025 thresholds are <34 kg for men and <20 kg for women aged 50–64 years, while thresholds of <28 kg for men and <18 kg for women apply at age ≥65 years.[4] These thresholds represent the muscle-strength component of the AWGS framework and do not by themselves diagnose sarcopenia, which additionally requires low muscle mass. The 2025 framework does not provide a diagnostic HGS threshold for adults younger than 50 years.[4]

The primary objective of this study was therefore to describe maximum bilateral HGS across hospital occupational categories with explicit sex stratification and to determine whether observed occupational differences persisted after adjustment for age, sex and BMI. A secondary objective was to describe the proportion of workers aged 50–64 years below AWGS 2025 HGS reference thresholds. No diagnostic inference regarding sarcopenia, nutrition status or physical activity was intended.

MATERIALS AND METHODS

2.1 Study Design and Setting

This was a cross-sectional analysis of routinely collected workforce health-assessment data from a tertiary-care hospital in Mumbai, India. Reporting was revised in accordance with STROBE principles for cross-sectional studies.[5]

2.2 Participant Selection and Data Cleaning

The workforce worksheet contained 684 rows with numeric employee identifiers. After removal of 192 exact duplicate records, 492 unique rows remained. Repeated records belonging to the same employee identifier were resolved to one employee record, leaving 449 unique employees. Three employees lacked complete age, sex or bilateral HGS data, and one additional employee lacked usable BMI data, resulting in a final analytic sample of 445 employees (Figure 1). Nursing-student records from a separate worksheet were not included because the present analysis was restricted to employed staff.

2.3 Occupational Coding

Free-text department labels were standardized using prespecified equivalence rules derived from the workforce dataset. For example, “doctor” and “doc” were coded as Doctor; “nursing” and “nrsing” as Nursing; “HK” and janitorial entries as Housekeeping; physiotherapy abbreviations as Physiotherapist; “AKD” and “HD tech” as Dialysis technician; pharmacy variants as Pharmacy staff; security/PS as Security; infection-control variants as Infection control technician; and engineering/technical abbreviations as Engineering team. The detailed standardized occupations were retained rather than combined into broad occupational clusters. Occupation-specific inferential analyses were restricted to categories with at least 10 participants to reduce instability from very small groups; employees in smaller occupations remained in overall descriptive analyses.

2.4 Handgrip Strength Measure

Right and left HGS values were available in the workforce dataset. Hand dominance was not recorded. Therefore, right-versus-left HGS was not interpreted as dominant-versus-nondominant strength and no right-left comparison was performed. The higher of the two recorded handgrip values was used as maximum bilateral HGS for the primary analysis. This avoids assigning dominance retrospectively and reduces the influence of an isolated lower unilateral measurement.

2.5 AWGS 2025 secondary reference analysis

AWGS 2025 was used only as a secondary age-appropriate reference. Participants aged 50–64 years were classified relative to HGS thresholds of <34 kg for men and <20 kg for women.4 No participant in the dataset was aged ≥65 years. Participants younger than 50 years were not classified using AWGS 2025 thresholds because the consensus does not provide diagnostic HGS cutoffs for that age group. Classification below the HGS threshold was not interpreted as sarcopenia because skeletal muscle mass was not measured.

2.6 Statistical analysis

Continuous variables are summarized as mean ± standard deviation and categorical variables as number and percentage. HGS is presented separately for women and men. Occupation-specific descriptive comparisons were limited to standardized occupations with at least 10 participants and include the sex distribution and mean age of each occupation. A multivariable linear regression model assessed the association between occupational category and maximum bilateral HGS after adjustment for age, sex and BMI; Nursing, the largest occupational group, was used as the reference category. Heteroscedasticity-robust (HC3) standard errors were used. Regression coefficients are presented with 95% confidence intervals. The AWGS 2025 comparison is descriptive only. A two-sided p value <0.05 was considered statistically significant.

2.7 Ethical considerations

The study was conducted under the protocol "Incidence of Malnutrition in the Working Population" and was approved by the Institutional Ethics Committee (approval date: 29 July 2023). Written informed consent was obtained from all participants. The present analysis is limited to workforce muscle-strength profiling and does not infer nutritional status from HGS.

RESULTS

3.1 Participant characteristics

The final analytic cohort included 445 employees: 279 women (62.7%) and 166 men (37.3%). The mean age was 34.0 ± 10.2 years. Women were younger than men on average. Because HGS differed markedly by sex, a pooled overall HGS mean is not used for interpretation; sex-specific values are reported throughout (Table 1). Mean maximum bilateral HGS was 18.1 ± 4.6 kg in women and 30.5 ± 8.9 kg in men.

Table 1: Participant characteristics presented with sex-specific handgrip strength

Characteristic	Overall	Women	Men
Participants, n	445	279	166
Age, years	34.0 ± 10.2	31.2 ± 8.6	38.6 ± 11.1
BMI, kg/m²	—	23.3 ± 4.5	24.7 ± 3.7
Maximum bilateral HGS, kg	Not pooled	18.1 ± 4.6	30.5 ± 8.9
Age 50–60 years, n	55	19	36

Note: HGS was intentionally not pooled across sexes. Right and left values are not reported separately because handedness was unavailable; maximum bilateral HGS was used.

3.2 Occupation-specific profiles

The occupational categories differed substantially in sex composition and age (Table 2). Nursing was predominantly female and younger, whereas housekeeping, human resources and billing/TPA included older workers and a higher proportion of men. Consequently, crude occupational HGS values cannot be interpreted as direct occupation effects. Sex-stratified occupation-specific HGS values are shown in Table 2 and Figure 1.

Table 2: Sex-stratified HGS profile for occupational categories with at least 10 participants

Occupation	n	Women, n (%)	Age, years	Women HGS, kg	Men HGS, kg
Nursing	177	156 (88.1)	27.4 ± 5.5	18.4 ± 4.8 (n=156)	36.0 ± 10.1 (n=21)
Housekeeping	100	39 (39.0)	42.0 ± 10.6	16.6 ± 4.9 (n=39)	28.6 ± 8.1 (n=61)
Administrative staff	22	17 (77.3)	35.6 ± 10.3	20.1 ± 5.0 (n=17)	28.2 ± 7.9 (n=5)
Laboratory technician	22	17 (77.3)	36.1 ± 9.6	17.8 ± 3.2 (n=17)	29.0 ± 6.4 (n=5)
Doctor	21	11 (52.4)	29.8 ± 3.3	17.7 ± 3.6 (n=11)	35.5 ± 9.7 (n=10)
Human resources	18	6 (33.3)	38.9 ± 9.4	16.8 ± 2.7 (n=6)	30.0 ± 10.4 (n=12)
Security	13	7 (53.8)	38.5 ± 9.1	20.0 ± 4.6 (n=7)	36.0 ± 10.7 (n=6)
Billing/TPA	11	4 (36.4)	41.4 ± 12.0	19.0 ± 4.8 (n=4)	24.7 ± 7.9 (n=7)
Pharmacy staff	11	3 (27.3)	33.4 ± 7.9	14.0 ± 4.6 (n=3)	31.0 ± 4.7 (n=8)

Occupations with fewer than 10 participants (operation theatre, infection control, information technology, clinical dietetics, blood bank, engineering, physiotherapy, respiratory therapy, dialysis and CSSD) were retained in overall descriptive analyses but were not used for occupation-specific inferential comparisons.

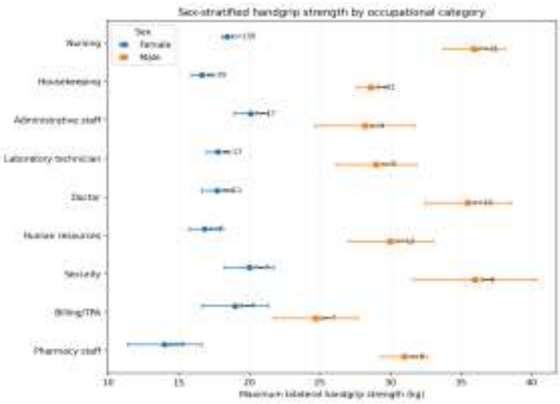

Figure 1: Sex-stratified maximum bilateral handgrip strength by occupational category. Error bars show standard error; n values are displayed for each sex within each occupation

3.3 Adjusted occupational analysis

The adjusted model included 395 employees from the nine occupational categories with at least 10 participants. After adjustment for age, sex and BMI, none of the individual occupational categories differed significantly from Nursing, the reference group (Table 3; Figure 2). The largest adjusted difference was observed for Billing/TPA (−4.33 kg, 95% CI −9.07 to 0.41; p=0.074), but the confidence interval included zero. Age, sex and BMI were retained as adjustment variables rather than interpreted as novel predictors: HGS decreased by 0.15 kg per year of age, was 13.81 kg higher in men than women, and increased by 0.34 kg per kg/m² of BMI in this model.

Table 3: Multivariable linear regression for maximum HGS

Variable	Adjusted β (kg)	95% CI	p value
Male sex (vs women)	+13.81	12.00 to 15.63	<0.001
Age, per year	−0.15	−0.24 to −0.07	<0.001
BMI, per kg/m²	+0.34	0.17 to 0.51	<0.001
Administrative staff	−0.26	−3.07 to 2.55	0.856
Billing/TPA	−4.33	−9.07 to 0.41	0.074
Doctor	+0.21	−3.11 to 3.53	0.901
Housekeeping	−1.74	−3.70 to 0.22	0.082
Human resources	−1.53	−5.49 to 2.42	0.448
Laboratory technician	−0.94	−2.96 to 1.09	0.364
Pharmacy staff	−1.63	−4.99 to 1.73	0.341
Security	+2.42	−1.95 to 6.79	0.278

Reference occupation: Nursing. Model n=395; R^2=0.522. HC3 heteroscedasticity-robust standard errors were used. Occupation coefficients represent adjusted mean differences in HGS relative to Nursing.

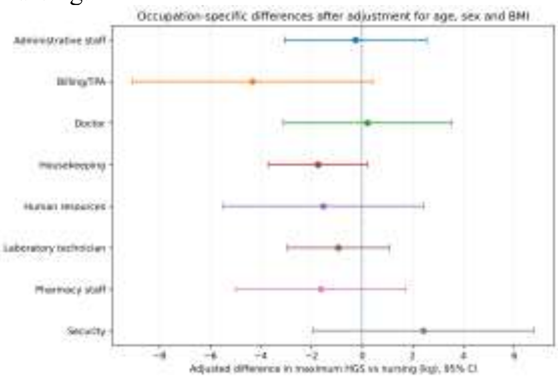

Figure 2: Adjusted occupation-specific differences in maximum bilateral HGS relative to Nursing. Estimates are adjusted for age, sex and BMI; error bars show 95% confidence intervals

3.4 Secondary AWGS 2025 comparison

Fifty-five employees were aged 50–60 years and therefore fell within the AWGS 2025 middle-aged category (50–64 years). No participant was aged ≥65 years. Using AWGS 2025 HGS reference thresholds (<20 kg for women and <34 kg for men), 12 of 19 women (63.2%) and 32 of 36 men (88.9%) were below the age-specific strength threshold (Table 4). These proportions represent only the HGS component of AWGS 2025 and are not estimates of sarcopenia prevalence.

Table 4: Secondary AWGS 2025 HGS reference comparison among employees aged 50–60 years

Sex	n	AWGS 2025 HGS threshold	Mean HGS, kg	Below threshold, n (%)
Women	19	<20 kg	17.4 ± 4.9	12 (63.2)
Men	36	<34 kg	25.1 ± 7.7	32 (88.9)
Total	55	Sex-specific	—	44 (80.0)

Note: AWGS 2025 defines HGS thresholds for ages 50–64 and ≥65 years. The present dataset contained no participant aged ≥65 years. Low HGS alone does not diagnose sarcopenia; muscle-mass criteria are also required.

DISCUSSION

This revised analysis addresses the central interpretive problems of pooled-sex reporting, right-versus-left hand comparisons without handedness information, arbitrary occupational clustering and indiscriminate application of older AWGS thresholds. HGS was therefore analyzed as a continuous, sex-stratified workforce measure, with occupation interpreted only after accounting for age, sex and BMI.

The most striking descriptive finding was the large expected sex difference in HGS. Because the occupational categories also differed markedly in sex composition and age, pooled occupational means were potentially misleading. For example, Nursing was predominantly female and younger, whereas Housekeeping and Human Resources included more men and older employees. The sex-stratified values in Table 2 therefore provide a more interpretable description than a single pooled mean for each occupation.

After adjustment for age, sex and BMI, none of the occupation categories with at least 10 participants showed a statistically clear difference from Nursing. This suggests that much of the apparent between-occupation variation in the unadjusted data may reflect demographic and body-size composition rather than an occupation-specific effect. This is an important occupational-health observation because it cautions against ranking departments by crude HGS values. The current dataset does not contain sufficiently detailed information on workload, shift patterns, physical activity, socioeconomic status, nutrition, comorbidities or musculoskeletal limitations to determine why individuals or occupational groups differ in strength.

Hand dominance was also not available. Accordingly, right and left measurements were not compared as if they represented dominant and nondominant hands. Maximum of bilateral HGS was used as the primary measure. This analytic choice avoids assigning dominance retrospectively, but it should not be interpreted as equivalent to a standardized dominant-hand protocol. Future occupational studies should record handedness, testing position, number of attempts and the precise rule used to derive the final HGS value.

The AWGS framework also required updating. AWGS 2025 introduced specific HGS cutoffs for adults aged 50–64 years (<34 kg for men and <20 kg for women), while retaining lower thresholds for adults aged ≥65 years.[4] In the present cohort, all participants were younger than 65 years and only 55 were aged 50–60. Therefore, AWGS 2025 was applied only to this subgroup. The high proportion below the HGS threshold should be interpreted cautiously: AWGS 2025 diagnosis of sarcopenia requires both low muscle strength and low muscle mass, and the present study did not measure muscle mass.[4]

Indian normative HGS data are especially relevant to the interpretation of a younger workforce. Singh and colleagues reported sex-specific HGS cutoffs derived from healthy Indian adults that were lower than the AWGS 2025 thresholds used for 50–64-year-old Asian adults.[6] This difference reinforces the importance of age-, sex- and population-specific reference standards and argues against treating a single threshold as universally diagnostic in occupational cohorts.

5. Strengths and Limitations

Strengths include a relatively large hospital workforce sample, bilateral HGS measurements, transparent duplicate removal, standardized mapping of free-text occupations, sex-stratified reporting and an occupation-focused adjusted analysis. The revised analysis also avoids pooled-sex HGS interpretation and restricts AWGS 2025 comparisons to the age range for which the guideline provides thresholds.

Important limitations remain. The study is cross-sectional and single-center. Hand dominance, physical activity, socioeconomic status, dietary intake, job tenure, objective occupational workload, comorbidities, musculoskeletal pain or limitation, and body composition were not captured. Therefore, residual confounding is substantial and occupation cannot be interpreted causally. Several detailed occupations had small sample sizes and were excluded from occupation-specific inferential analysis using a prespecified minimum of 10 participants. HGS values came from routine workforce records, and the number of attempts and exact standardization of dynamometer technique could not be independently verified from the analytic dataset. Finally, AWGS 2025 HGS thresholds are only a secondary reference; sarcopenia cannot be diagnosed from HGS alone.

CONCLUSION

Handgrip strength in this hospital workforce differed strongly by sex and age, and occupational groups had substantially different demographic compositions. Crude occupational HGS comparisons should therefore be interpreted cautiously. After adjustment for age, sex and BMI, this study did not demonstrate clear occupation-specific differences among the occupational categories with adequate sample size. Future workforce studies should combine standardized HGS measurement with handedness, physical activity, workload, socioeconomic, comorbidity and body-composition data. AWGS 2025 thresholds may be used as an age-specific secondary reference in workers aged 50–64 years, but HGS alone should not be used to diagnose sarcopenia.

Declarations

Ethics approval and consent to participate: Approved by the Institutional Ethics Committee (approval date: 29 July 2023). Written informed consent was obtained from all participants.

Funding: No external funding was received.

Conflicts of interest: The authors declare no conflicts of interest.

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Author contributions: SS conceived the study, performed the statistical analysis, interpreted the data and drafted the manuscript. KP contributed to data collection, data verification and manuscript review. Both authors approved the final manuscript.

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