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Research Article

Handgrip Strength Increase is Modulated by the Risk of Malnutrition After Dental Prostheses

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Abstract

Background: A common goal of the health professions is to maintain the functional ability of the elderly, thereby preventing sarcopenia and frailty. Maintaining natural dentition or using Removable Partial Dentures (RPDs) is crucial for maintaining masticatory functionality, ensuring proper nutrition and avoiding geriatric syndromes in the elderly population. Handgrip Strength (HGS) has been described as a predictor of geriatric syndromes.

Aim: To assess changes in HGS in relation to malnutrition risk and masticatory function after using dental prosthetics.

Materials and Methods: Pre-post prospective, quasi-experimental study. Between March 2020 and 2022, older adults aged 70-79 years who had no molars or premolars and signed informed consent were selected. According to the Eichner index, they were categorized by masticatory functionality and assessed for malnutrition risk using calf circumference. HGS measurements were taken at baseline, during dental prosthesis installation and 15 days later, using a manual hydraulic dynamometer. Differences in HGS were analyzed with a mixed linear regression model using SAS 9.4 software ($p < 0.05$).

Results: 307 older adults with an average age of 75.3 years (±2.74), including 176 women and 131 men. No differences were found in baseline HGS between individuals with no risk (11.8 kg) and those at risk of malnutrition (11.7 kg) ($p = 0.92$). A significant increase in HGS was observed immediately after prosthesis installation in participants with no risk (13.1 kg) and at risk (12.4 kg) ($p < 0.001$). After 15 days, the HGS of patients with no risk increased to 14.3 kg and at risk to 12.9 kg ($p < 0.001$). In the sample, older adults with better masticatory function, as measured by the Eichner index, demonstrated significant improvements, with increased HGS in both those with no risk and those at risk of malnutrition ($p < 0.001$).

Conclusion: The use of dental prostheses immediately increased the HGS, both at the time of installation and 15 days later, influenced by the risk of malnutrition and masticatory function.

Keywords: Handgrip Strength; Dental Prosthesis; Malnutrition Risk

Introduction

Hand Grip Strength (HGS) is a key indicator of muscle function and overall physical ability. Especially important for the aging population, HGS has a strong connection to sarcopenia, a condition characterized by the age-related loss of muscle mass, strength and function. While sarcopenia is well-studied [1,2]. HGS as an isolated issue has received much less attention [3]. There is extensive international evidence showing that handgrip strength is a valuable health biomarker because of its association with overall muscle strength, as well as its links to chronic non-communicable diseases and mortality among adults and older adults. Additionally, it is widely used in diagnosing common geriatric syndromes such as sarcopenia and frailty [4]. Several health conditions, including Type 2 diabetes, cardiovascular disease, stroke, chronic kidney and liver disease, some cancers, sarcopenia and fragility fractures, have shown a correlation with low HGS. Low HGS is also associated with increased hospitalization, poor nutritional status, higher overall mortality and a reduced quality of life. A thorough analysis of existing data and various health parameters reveals significant links between HGS and health outcomes, including mortality [5].

In healthy individuals, age and gender are the main factors affecting hand grip strength [6]. However, in cases of acute or chronic illness, other factors, such as disease severity, comorbidity load, medical treatments and immobilization, also influence muscle weakness and, in turn, the overall well-being of patients. Still, hand grip strength remains a simple bedside measure that offers valuable insights beyond assessing nutritional and/or functional status. To identify patients at risk, dependable cutoff values still need to be established and validated [7]. Recent studies have explored the connection between hand grip strength and oral health, including the number of teeth [8,9].

Furthermore, handgrip strength is a crucial part of frailty, as it indicates poor nutrition and muscle weakness in older adults [10]. It serves as an indicator of sarcopenia in this population [11]. Some research has suggested a link between poorly fitting dentures, chewing ability and sarcopenia in older adults [12,13].

Geriatric syndromes are often the cause of functional or social disability in the elderly. Maintaining natural teeth or using Removable Partial Dentures (RPDs) is essential for preserving chewing function, which, in elderly patients, depends on the extent of tooth loss [14]. Additionally, dietary intake in some individuals is linked to occlusal force rather than the number of teeth, while in others, it is associated with the number of teeth [15,16]. Loss of posterior occlusal support (premolars and molars) alters occlusal force and the ability to chew [17]. The Eichner index helps classify occlusal contacts, with categories A, B and C indicating the progression of posterior occlusal support loss and the functional status of the dentition for mastication [18]. The number of teeth has been associated with frailty. Horibe, et al., found that low occlusal force is related to frailty and that reduced chewing ability is linked to sarcopenia in the elderly [19]. Yamaga, et al., reported that fewer teeth lead to decreased total muscle mass and slower walking speed [20]. Recently, the number of remaining teeth and occlusal force have been identified as predictors of cognitive decline [21].

Low HGS is associated with higher mortality, prolonged hospitalization and increased risks of falls and fractures [22]. Consistent with international guidance, functional capacity is a central metric of health in older adults. This study aimed to quantify immediate and 15-day changes in HS following prosthetic rehabilitation that re-establishes posterior occlusal support and to examine whether these changes differ by malnutrition risk and masticatory function. Clarifying the HGS response to prosthetic rehabilitation and its potential modulation by nutritional status may inform integration of oral rehabilitation within comprehensive geriatric care.

Material and Methods

Study Design and Setting

A pre-post study with three repeated assessments of Handgrip Strength (HGS) surrounding the delivery of removable dental prostheses was carried out in dental centers in Santiago, Chile, between March 2020 and March 2022. The design was chosen to describe the immediate and short-term functional response to standard prosthetic rehabilitation under routine clinical conditions.

Participants

Community-dwelling older adults aged 70-79 years referred for prosthetic rehabilitation were screened for eligibility because this group is at heightened risk for sarcopenia and functional decline while remaining sufficiently robust to benefit from prosthetic rehabilitation [9]. Inclusion required the absence of posterior occlusal support (i.e., missing premolars and molars) and the provision of written informed consent. Masticatory function was classified according to the Eichner index (categories B and C) [23]. Exclusion criteria included refusal to participate, cognitive or sensory impairment, functional dependence that prevented reliable evaluation or Eichner categories outside the target range. A total of 351 individuals were screened; 307 met eligibility criteria, completed all scheduled assessments and were included in the analysis. This study enrolled all eligible older adults during the recruitment window. No formal a priori sample size calculation was performed, as the design was feasibility-based.

Intervention (Dental Prosthetic Rehabilitation)

Conventional RPDs were fabricated and delivered following standard prosthodontic protocols. Mouth preparation, surveying and framework design were carried out as needed; definitive impressions and intermaxillary records were taken, casts were mounted on an articulator and teeth were arranged to restore posterior contacts without changing the recorded vertical dimension. At delivery, occlusion and pressure zones were adjusted as necessary, retention and stability were checked and standard hygiene and usage instructions were given. Prostheses were inserted in a single session, with a routine review at day 15 to evaluate adaptation, occlusion and soft tissue health, adjusting as required. No experimental device or adjunctive therapy was employed.

Outcomes and Measurement Procedures

The primary outcome was HGS of the dominant hand following a standardized protocol measured at three time points: before prosthesis installation (baseline), immediately after Installation (immediate) and 15 days afterwards (day 15) [24]. Measurements were taken using a manual hydraulic dynamometer following a standardized seated protocol. Two attempts were recorded at each time point while participants clenched their teeth; the higher value (kg) was used for analysis. Outcome assessments were performed with blinding to group assignment.

Calf circumference was used as a screening indicator of malnutrition risk using a protocol and thresholds validated for older adults [25]. Measurements were taken at the most prominent part of the calf with the participant seated, with the knee flexed at approximately 90°, the foot flat on the floor and the muscles relaxed. A non-elastic tape was placed perpendicular to the long axis of the leg and gently pressed against the skin without indentation; measurements were recorded to the nearest 0.1 cm. Risk categories were determined based on established geriatric thresholds to classify participants as "at risk of malnutrition" or "no risk". Body Mass Index (BMI) was calculated as weight (kg) divided by height squared (m^2). Weight was measured without shoes and with light clothing using a calibrated digital scale; height was measured with a wall-mounted stadiometer with the Frankfurt plane horizontal. BMI was recorded at baseline and on day 15.

Masticatory function was evaluated using the Eichner index validated protocol which classifies occlusal support based on the presence of contacts in four posterior support zones (left and right premolar-molar regions) [23]. Occlusal contacts were identified in maximum intercuspation using articulating paper under light bite closure and calibrated examiners assigned the category. Category A indicates contacts in all four support zones (full posterior support). Category B indicates contacts in one to three support zones (reduced posterior support). Category C indicates no occlusal contacts in any of the support zones (no posterior support). For this analysis, categories B and C encompassed the spectrum of impaired posterior support.

Quality Assurance

Three calibrated operators performed all clinical and measurement procedures. Inter-operator agreement was substantial (Kappa = 0.79), confirming the reliability of classification and outcome measurement.

Sample Size and Analytic Population

Of the 351 individuals screened, 307 provided complete HGS data at all three scheduled assessments and were retained for longitudinal analyses without imputation.

Statistical Analysis

Categorical variables were summarized as counts and percentages and compared across groups using χ^2 tests. Continuous variables were summarized as means (SD) and compared between categories using univariate least-squares linear regression. Within-person HGS trajectories were modeled using linear mixed-effects regression for repeated measures with an unstructured covariance matrix, implemented in SAS 9.4. Time points (baseline, immediate post-installation, day 15) were specified as the main within-subject factor. Models were adjusted for gender, age and body mass index. Prespecified contrasts evaluated differences based on malnutrition risk (no risk versus at risk) and masticatory function, as assessed by the Eichner index. Statistical significance was assessed with two-sided tests at $\alpha = 0.05$.

Results

The analytic cohort included 307 older adults (176 women, 131 men) with a mean age of 75.3 years (SD, 2.74). The sample had a higher proportion of women than men (Table 1). BMI varied significantly between participants at no risk and at risk of malnutrition (Table 2). Masticatory function was distributed across Eichner categories B and C, with a gender-related difference observed within category B2 (Table 3).

Handgrip Strength at Baseline and Immediately After Prosthesis Installation

At baseline, HGS was similar across nutritional groups, with mean values of 11.8 kg in the no-risk group and 11.7 kg in the at-risk group ($p = 0.92$). Right after prosthesis placement, HGS increased in both groups, reaching 13.1 kg and 12.4 kg, respectively ($p < 0.001$ for within-group change). The immediate response is shown in Fig. 1 and summarized in Table 4.

Short-Term (15-Day) Changes

By day 15, HGS showed further improvement, reaching 14.3 kg in the no-risk group and 12.9 kg in the at-risk group ($p < 0.001$ for within-group change from baseline). The overall 15-day increase from baseline was +2.4 kg in participants with no risk of malnutrition and +1.1 kg in those at risk, indicating that nutritional status influenced the extent of functional improvement (Fig. 1; Table 4). In mixed-effects models for the entire cohort, time effects were statistically significant across assessments, confirming a rapid, immediate increase followed by further short-term consolidation (Table 4).

Influence of Masticatory Function Within Nutritional Strata

Stratified analyses showed that masticatory function was positively linked to HGS levels and the degree of improvement after installation within each nutrition group. Among participants not at risk of malnutrition (Table 5), a higher Eichner status was associated with higher HGS at each time point and greater gains from baseline to immediately after and on day 15. A similar pattern was observed among participants at risk of malnutrition (Table 6), although with smaller absolute gains compared to the no-risk group. These trends are illustrated in Fig. 2.

	Men	Women	Total	p-value
n	131	176	307	0.010
Age	75.4 (2.0)	75,1 (2.2)	75,3 (4.8)	0.667
Malnutrition: no risk	105	136	241	0.048
Malnutrition: at risk	26	40	66	0.089

Table 1: Sample distribution. Comparisons of categorical distributions are performed using χ^2 tests. Continuous variables were summarised as means (SD) and compared between categories using univariate least-squares linear regression. The sample is composed of more women than men.

	No risk	At risk	p-value
BMI	24.8 (1.3)	23.8 (2.5)	0.004

Table 2: Body mass index. Continuous variables were summarised as means (SD) and compared between categories using univariate least-squares linear regression. There is a significant difference between the sample at no risk and the sample at risk of malnutrition.

Eichner	n	Age (years)	Sex	p-value
B1	100	74,2 (2,9)	♂= 45 ♀ = 55	0.317
B2	69	75,1 (2,7)	♂= 26 ♀ = 43	0.041
B3	24	75,3 (2,6)	♂= 13 ♀ = 11	0.683
B4	16	76,3 (2,1)	♂= 9 ♀ = 7	0.617
C1	35	76,3 (2,1)	♂= 14 ♀ = 21	0.237
C2	63	76,3 (2,5)	♂= 24 ♀ = 39	0.059

Table 3: Sample distribution by masticatory function. Comparisons of categorical distributions were conducted using χ^2 tests. Continuous variables were summarized as means (SD) and compared across categories using univariate least-squares linear regression. There is a statistically significant difference in sex within category B2.

Malnutrition	HS measure	HS	DifferenceΔ	Δ 95% CI	p-value
No Risk	Baseline	11.8 kg (± 0.06)	Referent	Referent	Referent
	Post-installation	13.1 kg (± 0.07)	1.3 kg	(1.2 kg, 1.4 kg)	<.0001
	15 days	14.3 kg (± 0.08)	2.5 kg	(2.6 kg, 2.4 kg)	<.0001
At Risk	Baseline	11.7 kg (± 0.1)	Referent	Referent	Referent
	Post-installation	12.4 kg (± 0.13)	0.7 kg	(0.4 kg, 0.8 kg)	<.0001
	15 days	12.9 kg (± 0.16)	1.2 kg	(0.8 kg, 1.3 kg)	<.0001

Table 4: Differences in handgrip strength across malnutrition risk categories and measurements, adjusted for sex, age, BMI and masticatory function. Across the entire sample, there were statistically significant differences in handgrip strength.

Malnutrition	Masticatory Function	HS measure	HS	DifferenceΔ	Δ 95% CI	p-value
No Risk	B1	Baseline	14.2 kg (± 0.08)	Referent	Referent	Referent
		Post-installation	15.9 kg (± 0.1)	1.7 kg	(1.6 kg, 1.8 kg)	<.0001
		15 days	17.4 kg (± 0.12)	3.2 kg	(3.0 kg, 3.4 kg)	<.0001
	B2	Baseline	13.1 kg (± 0.1)	Referent	Referent	Referent
		Post-installation	14.3 kg (± 0.13)	1.2 kg	(1.1 kg, 1.4 kg)	<.0001
		15 days	15.2 kg (± 0.16)	2.1 kg	(1.9 kg, 2.4 kg)	<.0001
	B3	Baseline	12.9 kg (± 0.17)	Referent	Referent	Referent
		Post-installation	14.1 kg (± 0.23)	1.2 kg	(0.9 kg, 1.5 kg)	<.0001
		15 days	15.4 kg (± 0.28)	2.5 kg	(2.0 kg, 2.8 kg)	<.0001
	B4	Baseline	12.5 kg (± 0.2)	Referent	Referent	Referent
		Post-installation	13.8 kg (± 0.28)	1.3 kg	(1.1 kg, 1.7 kg)	<.0001
		15 days	14.9 kg (± 0.34)	2.4 kg	(1.9 kg, 2.9 kg)	<.0001
	C1	Baseline	8.9 kg (± 0.16)	Referent	Referent	Referent
		Post-installation	10.0 kg (± 0.2)	1.1 kg	(0.9 kg, 1.3 kg)	<.0001
		15 days	10.9 kg (± 0.24)	2.0 kg	(1.7 kg, 2.3 kg)	<.0001
	C2	Baseline	9.0 kg (± 0.11)	Referent	Referent	Referent
		Post-installation	10.0 kg (± 0.15)	1.0 kg	(0.8 kg, 1.1 kg)	<.0001
		15 days	10.9 kg (± 0.18)	1.9 kg	(1.6 kg, 2.1 kg)	<.0001

Table 5: Differences in handgrip strength between masticatory function categories in patients with no risk of malnutrition, adjusted for sex, age and BMI.

Malnutrition	Masticatory Function	HS measure	HS (Std. Error)	DifferenceΔ	Δ 95% CI	p-value
At Risk	B1	Baseline	14.0 kg (0.24)	Referent	Referent	Referent
		Post-installation	14.7 kg (0.32)	0.7 kg	(0.3 kg, 1.0 kg)	0.001
		15 days	15.2 kg (0.38)	1.2 kg	(0.6 kg, 1.7 kg)	<.0001
	B2	Baseline	13.2 kg (0.19)	Referent	Referent	Referent
		Post-installation	13.9 kg (0.25)	0.7 kg	(0.3 kg, 0.9 kg)	<.0001
		15 days	14.4 kg (0.29)	1.2 kg	(0.7 kg, 1.6 kg)	<.0001
	B3	Baseline	13.9 kg (0.3)	Referent	Referent	Referent
		Post-installation	14.4 kg (0.4)	0.5 kg	(0.1 kg, 1.0 kg)	0.024
		15 days	14.8 kg (0.48)	0.9 kg	(0.2 kg, 1.7 kg)	0.006
	B4	Baseline	12.0 kg (0.38)	Referent	Referent	Referent
		Post-installation	12.8 kg (0.5)	0.8 kg	(0.3 kg, 1.4 kg)	0.002
		15 days	13.3 kg (0.59)	1.3 kg	(0.5 kg, 2.2 kg)	0.002
	C1	Baseline	8.7 kg (0.22)	Referent	Referent	Referent
		Post-installation	9.2 kg (0.3)	0.5 kg	(0.2 kg, 0.8 kg)	0.002
		15 days	9.8 kg (0.36)	1.1 kg	(0.5 kg, 1.5 kg)	<.0001
	C2	Baseline	8.9 kg (0.18)	Referent	Referent	Referent
		Post-installation	9.6 kg (0.23)	0.7 kg	(0.4 kg, 0.9 kg)	<.0001
		15 days	10.1 kg (0.27)	1.2 kg	(0.7 kg, 1.5 kg)	<.0001

Table 6: Differences in handgrip strength between masticatory function categories in patients at risk of malnutrition, adjusted for sex, age and BMI.

Discussion

This study aimed to examine immediate and short-term changes in Handgrip Strength (HGS) following the restoration of posterior occlusal support with removable dental prostheses in older adults. It also sought to evaluate whether these changes varied according to malnutrition risk and masticatory function, as classified by the Eichner index.

Masticatory function, as operationalized by the Eichner index, serves as a clinically informative proxy for posterior occlusal support. Categories B and C denote reduced and absent occlusal support, respectively and are associated with diminished chewing performance and selective avoidance of hard, fibrous and dry foods. These adaptations are relevant to energy and protein intake, as well as fiber consumption, thereby linking occlusal status with nutritional profile [25-27]. Restoration of molar contacts facilitates the consumption of protein-rich foods (e.g., meat, fish) and fiber-containing items (e.g., vegetables, fruit), providing a plausible pathway from prosthetic rehabilitation to improvements in nutritional adequacy and physical function [28].

After prosthesis placement, HGS increased rapidly and continued to rise by day 15 across Eichner categories and nutritional levels. The pattern over time indicates a quick, early functional response associated with re-established occlusal contacts, followed by short-term stabilization reflecting improved chewing efficiency and early meal adjustments. Absolute values and 15-day net changes were smaller among participants at risk of malnutrition compared to those not at risk, suggesting that existing nutritional vulnerabilities can limit the extent of functional improvement even when progress is positive. This gradient aligns with the conceptual pathway linking occlusal support to diet quality and, ultimately, to muscle performance [28].

Evidence linking oral hypofunction to sarcopenia offers a wider interpretive framework. Composite measures of oral hypofunction including indices of oral hygiene, xerostomia, occlusal force, oral diadochokinesis, tongue pressure and masticatory and swallowing function have been associated with HGS, gait speed and muscle mass index in multivariable analyses; higher rates of sarcopenia have been observed among individuals meeting criteria for oral hypofunction [29,30]. Restoring posterior occlusal support through prosthetic rehabilitation is expected to enhance various aspects of oral hypofunction, thereby influencing proxies of sarcopenia such as HGS. The immediate and short-term increases in HGS seen align with this framework and suggest potential benefits of prompt oral rehabilitation for physical function trajectories, especially in those without established malnutrition [29,30].

Determinants of baseline HGS in older adults include age-related muscle atrophy, sedentary behavior and loss of posterior occlusal support [31]. Tooth loss has been more strongly linked to masseter muscle thickness than to chronological age or skeletal muscle mass index in both sexes, highlighting the importance of dental status in masticatory muscle health and indirectly, in overall functional capacity [32]. In this context, the repeated association between restoring posterior dental contact and increases in HGS over 15 days supports mechanisms involving peripheral muscle activation during mastication, improved chewing efficiency and early improvements in nutritional intake.

Several limitations should be considered. First, the cohort consisted only of adults aged 70-79 years, which may restrict how well the findings apply to younger or older groups; future studies with a wider age range would be helpful. Second, the 15-day observation period does not allow for evaluation of the medium or long-term stability of the observed changes. Third, no detailed dietary assessment was performed, so the impact of specific macronutrients or nutritional patterns remains unknown. Fourth, this was a feasibility-focused, pre-post study that enrolled consecutive eligible patients without a non-rehabilitated control group; therefore, causal conclusions are limited and the precision reflects the sample size rather than an initial power calculation. Although models adjusted for age, sex and BMI, residual confounding from factors such as physical activity, comorbidity burden or medication use cannot be ruled out. Finally, the possibility of practice effects from repeated HGS testing exists; however, the consistent incremental improvements after baseline and similar patterns across Eichner categories and nutritional strata suggest measurement artifacts are unlikely to be the sole explanation.

From a clinical standpoint, restoring posterior occlusal support in older adults with impaired chewing ability was associated with quick, short-term gains in HGS. Combining prosthetic rehabilitation with screening and managing malnutrition risk may be crucial for comprehensive geriatric care, considering established links among oral function, diet quality and sarcopenia-related outcomes [25-27]. Future studies with longer follow-up, objective dietary assessments, direct measurement of masticatory performance and broader physical function indicators (e.g., gait speed, chair-stand tests) would help clarify the sustainability, dose-response relationships and applicability of these early functional gains.

Conclusion

Immediate and short-term increases in HGS were observed after installing removable dental prostheses, with changes evident at delivery and after 15 days. The degree of change depended on malnutrition risk and masticatory function, supporting a functional link between re-established posterior occlusal support, nutritional pathways and muscle performance in older adults.

Conflict of Interest

There are no conflicts of interest that may have influenced the research, authorship or publication of the article.

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Author Contributions

Pilar Barahona: Developed Conceptualization, Administration and investigation
Braulio Santibañez: Investigation
Matías Ríos-Erazo: Investigation
Andrés Celis: Methodology and Data Curation
Erik Dreyer: Methodology and Writing-original draft

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