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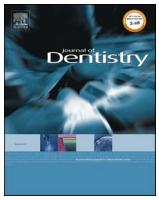

Cost-effectiveness-analysis of oral health remotivation and reinstruction in nursing homes in a cluster-randomized controlled trial

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ABSTRACT

Objectives: We conducted a cluster-randomized-controlled trial (cRCT) in 18 German nursing homes (NH) to evaluate the cost-effectiveness of reinstruction and remotivation of nursing staff by dental assistants (DAs) over 13 months.
Methods: In the intervention arm, dentists examined NH residents, identified oral health conditions, and prescribed individualized oral care interventions. Nursing staff delivered these interventions, with regular follow-up support from DAs (reinstruction and remotivation). In the control group, similar interventions were prescribed via a standardized form, without reinstruction and remotivation (standard of care). The primary outcome was Oral-Health-related Quality-of-Life (OHrQoL) using the Geriatric/General Oral Health Assessment Index (ADD-GOHAI). Secondary outcomes included Health-related Quality-of-Life (HrQoL) using the EQ-5D summary index and caries experience (DMFT index). Costs, including those for staff, materials, and travel, were assessed in Euro 2022. Cost-effectiveness ratios and bootstrapping simulations assessed cost-effectiveness-acceptability at different willingness-to-pay thresholds.
Results: Of 358 recruited participants, 68 and 63 in the intervention and control group completed the study. No significant differences existed between groups in demographics or baseline health measures. After 13 months, changes in ADD-GOHAI and DMFT scores were minimal and non-significant, while EQ-5D scores decreased in the intervention group ($p < 0.001$). Total costs were higher in the intervention arm (median 121.10 Euro) versus the control (median 0 Euro, $p < 0.001$), mainly due to travel expenses. The intervention increased dental service use but demonstrated lower cost-effectiveness acceptability.
Conclusions: DA-led reinstruction did not improve OHrQoL, negatively impacted HrQoL, and increased costs. Notably, our study was suffering from significant attrition, impacting on statistical power.
Clinical significance: Reinstruction and remotivation by dental assistants did not improve OHrQoL, but generated significant costs, mainly due to an uptake of dental services.
Trial registration: : ClinicalTrials.gov (Trial registration number NCT04140929)

1. Introduction

Nursing home (NH) residents are often affected by various physical and cognitive impairments, impacting on their self-efficacy, and oftentimes also require assistance with oral care [1]. NH residents regularly shower poor oral health [2,3] which, in turn, may reduce Oral-Health-related Quality-of-Life (OHrQoL) and increase the risk of systemic comorbidities [4,3].

We conducted a cluster-randomized trial with a complex intervention involving dental assistants (DAs) regularly following up on dentists'

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prescribed oral health interventions in 18 NHs in Germany. DAs actively interacted with nursing staff and reinstructed and remotivated them towards oral health and the prescribed interventions. Besides the yielded health outcomes, cost-effectiveness (among other aspects such as effectiveness, reach, maintenance, and implementation) is an increasingly relevant aspect of health interventions. Cost-effectiveness considers initial intervention costs, but also costs for diagnostics and treatments needed (or avoided) like conservative care (restorations, endodontic treatments), prosthetic care (repair or renewal of fixed or removable dental prostheses) or surgical procedures (like extractions). Initial intervention costs may be partially or fully compensated for by reduced costs for such items later [5]. Currently, health economic analyses are extremely scarce in dentistry, specifically in vulnerable groups like older individuals. We aimed to assess the cost-effectiveness of the described reinstruction and remotivation intervention after the trial period of 13 months.

2. Methods

2.1. Overview of the trial

We conducted a cluster-randomized controlled trial (cRCT) in 18 NH in Rhineland-Palatinate, Germany, including residents with moderate to severe care dependency [6], to improve NH residents' OHrQoL, general health, and dental health. In the intervention arm, dentists examined each participant, identified specific problems, and assigned individual oral hygiene and care interventions which nursing staff should apply regularly. During follow-up, DAs reinstructed and remotivated nursing staff to deliver the intervention(s). The control group was standard of care. Our primary health outcome was OHrQoL measured using the additive score of Geriatric/General Oral Health Assessment Index (ADD-GOHAI); further outcomes were general HrQoL (EQ-5D summary index) and caries experience (DMFT index).

This is a nested analysis within this cRCT [6]. The unit of randomization was the NH (i.e. the cluster). NHs were randomized either to the intervention group or the control group at a ratio of 1:1. Randomization was performed externally in the Institute of Medical Statistics at the University Hospital Jena using block randomization with variable block length. Reporting for this study follows the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) [7].

2.2. Comparators

Upfront, a systematic review of available interventions to improve oral health of residents of NHs was conducted [8]. The outcomes of this scoping review were then assessed for their implementation in German healthcare using a qualitative study [9]. Double-checking the resulting interventions showcased that all were all available on the standardized form developed by German authorities to instruct nursing staff towards oral health [10].

In both arms, NH residents were initially (T0) assessed by dentists to determine individual oral hygiene and care needs; this was documented using the mentioned standardized form. Dentists re-assessed residents after 6 (T1) and 13 months (T2, conclusion of the trial), respectively, for the health outcomes.

In the intervention group, DAs accompanied the study dentists at the measurement points T0 and T1, and through their presence, knew which instructions and motivation the dentists recommended to the nursing staff for each respective participant. DAs were required to visit all residents at least twice at approximately 4-week intervals in the 6-month follow-up periods between T0 and T1 and between T1 and T2. Reinstruction comprised support of nursing staff regarding the implementation of recommended measures as well as assistance in acquiring the necessary materials. Remotivation included conversation with nursing staff to increase awareness for the topic of oral hygiene or seeking tailored strategies for individual residents. All recommended interventions were documented by the DA in documents developed for this purpose.

The control group comprised care as usual, i.e. assignment of interventions from the standardized form, no further instruction of nursing staff, and no reinstruction and remotivation.

2.3. Target population, setting, sample size and recruitment

We enrolled residents in NHs in Rhineland-Palatinate, Germany. The target population were NH residents with moderate to high care dependency (care level three to five, as assessed by the medical service of the German social care insurance, considering mobility, cognitive and communicative abilities, the ability to organize daily life, social contacts). Respite care was excluded. We also excluded NHs with existing cooperation agreements, i.e. where dentists regularly attended each resident and cared for them according to German social insurance law SGB V §119b. Moreover, for the present evaluation, residents had to have reported ADD-GOHAI at T0 and T2, respectively, and had to have received the intervention at least once during the trial period (intervention arm only). Furthermore, patients solely receiving private care have been excluded from the analysis.

Sample size calculation is described in detail elsewhere and was based on the results of a 1-arm feasibility study [6]. In the latter, reinstruction and remotivating reduced the initial OHIP-G-14 from 14.0 to 6.5 (delta=7.5, SD=14.0). We assumed to observe at least this effect size with the given variance within the RCT. Using an unpaired *t*-test and given these assumptions, a total of 170 subjects (85 per group) were required to achieve a significance level of 5 % (two-sided) and a power of 80 %. The cluster randomization additionally increased this number by factor of 2.75, assuming 34 subjects per institution and an intra cluster correlation of 0.05 [11]. The target sample size per arm was therefore 238 subjects. Based on previous data of studies in NHs, we assumed the proportion of residents terminating the study early to be 30 % [12]. As a result, a total of 618 volunteers (in a total of approx.18 facilities) were required. Recruitment was significantly delayed due to the COVID-19 pandemic, and the study eventually only recruited 358 participants.

2.4. Staff

Dentists and DA were recruited in cooperation with the Dental Association of Rhineland-Palatinate. All teams were calibrated by the project management, co-management and coordinator in the facility; calibration for field examination was outlined elsewhere [13]. After six months, recalibration took place.

2.5. Health outcomes

Our primary endpoint was changes in OHrQoL between T0 and T2, assessed via ADD-GOHAI, an established instrument for measuring OHrQoL in older people [14,15]. It comprises twelve items in four domains (functional limitations, pain/discomfort, psychological aspects, behavioral aspects), which are recorded on a Likert-type scale from 1 (always) to 5 (never). We used the additive score ADD-GOHAI (minimum 12, maximum 60) as it provides a more nuanced assessment among the possible sum scores, with higher values indicating better oral health-related quality of life (OHrQoL).

A secondary endpoint was changes in general HrQoL, measured using the EuroQoL-five dimensions-five levels (EQ-5D-5L*)* tool. EQ-5D-5L health states can be represented by a single summary number (index value, EQ-5D summary index), where the minimum index value is -0.66 and the maximum 1 [16,17]. Another secondary endpoint was changes in caries experience/tooth loss, measured using the DMFT index. A high index value indicates a high caries experience/tooth loss (minimum 0; maximum 28)

2.6. Costs

To assess intervention costs, quantity and price units were recorded (micro-costing). We recorded:

(1) The time used for traveling to each NH, and the distances traveled, recorded by each DA in km. Median hourly gross costs for the DAs in this project (n=4) were 23.46 Euro and used to translate time into Euro. Distances travelled were transformed into Euro using the standard German mileage rate for Germany in 2022 at 0.38 Euro per km. Moreover, we estimated the costs for preparing visits and administrating the intervention; these were similarly recorded by the DA per NH and transferred into costs using median hourly gross costs. Travel costs and preparation administration costs were distributed among all NH residents, regardless of their inclusion in this study, as we assumed inclusion being an artificial parameter immanent in the study, and as in regular care, all residents would benefit from the DA visiting.
(2) The time the DA spent for the initial instruction by the dentists, as well as for reinstruction and remotivation, these were similarly transferred to Euro and distributed among all NH residents, as outlined.
(3) Costs for oral-health-related material used; using records made weekly by nursing staff; recorded materials were transferred into costs using cost estimates from a freely accessible price comparison webpage for medications (medizinfuchs, Berlin, Germany, accessed 29.11.2023) and assessed per participant.

To also reflect on costs for diagnostics and treatments needed in both groups (assuming that the intervention affected the need for diagnostics and treatments during the trial period), we employed routine claims data provided by the Association of Statutory Insurance Dentists, itemized using fee items of the statutory insurance, Bewertungsmaßstab (BEMA). BEMA fee items were mapped to categories (diagnostics, conservative dentistry, prosthodontics, surgery, and others), as shown in Supplementary Table 1. In Germany, dental care is fully or partially (e.g. prosthetic care) covered by the statutory (public) insurance for 87 % of the population [18]. The remaining population is covered by private insurance. In this analysis, all participants were publicly insured.

2.7. Perspective and horizon

The primary health economic evaluation was a cost-effectiveness analysis. Costs were collected from the perspective of a payer (for dental services, these were itemized as described above, while for all other costs, these were constructed from time spent or distances travelled, see above). OHrQoL (ADD-GOHAI) was our effectiveness value. The time horizon of the analyses was 13 months.

2.8. Currency, price date and discount rate

We estimated costs in Euro 2022. No discounting was conducted given 13-month analysis horizon of the trial.

2.9. Analytical methods

Incremental cost-effectiveness ratios were used for comparative analyses. Further sensitivity analyses along degrees of care, age or gender of residents were not conducted given the lower-than-estimated sample size.

Due to the skewness of the dataset and to assess the uncertainty stemming from our moderate sample size, we applied non-parametric bootstrapping to assess the impact of the variability of health outcomes and costs per group to determine the incremental cost effectiveness ratio (ICER) [19]. We conducted 1000 bootstrap simulations, where each simulation involved sampling with replacement from the original dataset to create a new sample of identical size. The median health outcome and cost were calculated for each bootstrap sample, generating a distribution of 1000 median estimates. Finally, a cost-effectiveness-acceptability curve was constructed at different willingness-to-pay thresholds (0–1500 Euro).

Post-hoc power analysis was performed to investigate the effect size necessary to detect a small effect (Cohen's $d = 0.2$) for the primary outcome (ADD-GOHAI) and secondary outcome (DMFT index) for a two tailed Mann-Whitney U test with an alpha error of 0.05 [20]. Notably, and as laid out, our sample size estimation was built on a larger effect estimate, which we were unable to detect in the final trial, though.

Health economic evaluations were performed using Python 3.12.1. Pandas v. 2.1.4 was used for data preparation and for processing tabular data. Statistical analyses were performed using SciPy v. 1.11.4. Seaborn v. 0.12.2 was used for data visualization. G*Power v. 3.1.9.6 was used for post-hoc power analysis. Comparisons of variables between groups were performed using the *t*-test for non-skewed continuous data, the Mann-Whitney *U test* for skewed continuous data and the Chi squared test for categorical data.

3. Results

Of the residents included in the study, we only included data if the primary endpoint was recorded at both T0 and T2. One NH in the intervention group had to be excluded, as no intervention measures could been undertaken, as accessibility of the NH was restricted due to COVID-19 measures (Fig. 1).

T0-T1 had a median duration of 183 days and T1-T2 had a median duration of 140 days, respectively. At T0, age and gender did not significantly differ between arms ($p > 0.05$; Table 1). Further, oral health measured by the DMFT index was not significantly better in the intervention arm (median = 28) compared to the control arm (median = 28, $p = 0.94$). ADD-GOHAI was similar in both arms at baseline, with the median being 53 for both groups which translates to a high OHrQoL. HrQoL measured by the EQ-5D summary index, was not statistically higher for the intervention arm with a median of 0.73 compared to a median of 0.64 in the control arm ($p = 0.07$).

Median changes between T0 and T2 in ADD-GOHAI were -1 for the intervention arm and 0 for the control arm; changes in EQ-5D summary index were -0.05 and 0.14, respectively. The differences in change between arms were not significant ($p > 0.05$) concerning OHrQoL but highly significant ($p < 0.001$) regarding HrQoL (see Table 1). DMFT was unchanged in both arms, respectively (Table 1). With the obtained sample sizes (Table 1), there was a power of 0.198 to confirm a small effect (Cohen's $d = 0.2$) for the primary outcome (ADD-GOHAI) and 0.194 for the secondary outcome (DMFT index). The obtained effect size d was 0.201 for ADD-GOHAI and 0 for DMFT index.

Total costs over the trial period were significantly higher in the intervention arm (median 126.10 Euro) than the control arm (0 Euro, $p < 0.001$). Costs in the intervention arm were driven by costs for traveling (i.e. travel distance and time spent for travel); costs for material were of the lowest importance (Table 2).

Costs for treatment and diagnostics were mainly driven by prosthodontics (Fig. 2b) (Supplementary Table 3), with a minority of residents (35 % and 27 % in the intervention and control arm, respectively) consuming any care (diagnostics or treatment) and generating any of these costs (Fig. 2a).

By further inspection, it was obvious that residents in the intervention arm consistently utilized more dental care across all service blocks, with the biggest difference in the number of utilized services being obvious for conservative care and diagnostics (Supplementary Table 2).

Individual cost-effectiveness ratios (Euro per change in ADD-GOHAI) are shown in Fig. 3a, and were disadvantageous for the intervention arm, as costs were higher at nearly no change in ADD-GOHAI. Using bootstrapping simulations, it became evident that for most simulations more money was spent while effectiveness was minimally lost (Fig. 3b).

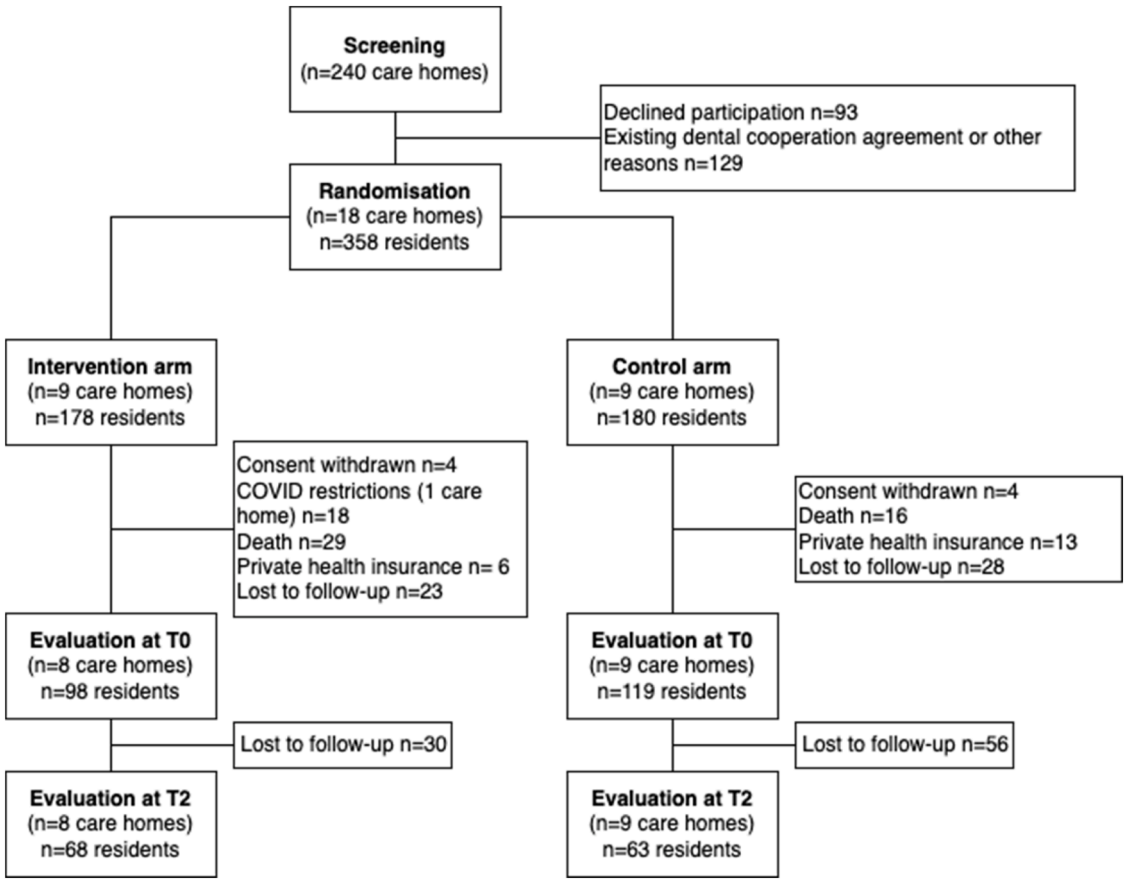

Fig. 1. Flowchart of the participants in both groups.

Table 1
Comparison of the two arms at baseline and after the trial. If not specified in the variable column, group sizes were n=68 in the intervention arm and n=63 in the control arm.

Variable	Intervention arm	Control arm	*p*-value
Nursing homes (n)	8	9	
Age in years at T0 (mean, SD), *t*-test	84.0 (8.4)	82.6 (8.3)	0.33
Gender female/male (n,%), Chi-squared test	49/19 (71/29 %)	41/22 (67/33 %)	0.76
Care level (3=n, 4=n, 5=n), Chi-squared test	37, 19, 7	31, 27, 5	0.32
Change in ADD-GOHAI (median, 25th and 75th percentile), Mann-Whitney U test	-1 [-6, 3]	0 [-6, 5]	0.41
Change in EQ-5D summary index (T2-T0) (n; median, 25th and 75th percentile); Mann-Whitney U test	63; -0.05 [-0.15, 0]	55; 0.14 [-0.07, 0.28]	<0.001
Change in DMFT index, (n; median, 25th and 75th percentile); Mann-Whitney U test	68; 0 [0, 0]	60; 0 [0, 0]	0.17
Total costs in Euro during study period (median, 25th and 75th percentile), Mann-Whitney U test	126.1 [94.53, 201.47]	0 [0, 31.84]	<0.001
Costs for the intervention in Euro during study period (median, 25th and 75th percentile), Mann-Whitney U test	95.65 [86.76, 124.11]	0 [0, 0]	<0.001
Costs for diagnostics and treatment in Euro (median, 25th and 75th percentile), Mann-Whitney U test	0 [0, 107.55]	0 [0, 31.84]	0.17

Table 2
Costs in the intervention arm, stratified by cost block, and assessed in total as well as per individual.

Cost block	Total sum in Euro	Sum per resident in Euro (mean, 25th percentile, 75th percentile)
Travel	3856.43	56.71 [41.09, 53.32]
Administration and preparation of visit	1395.40	20.52 [16.01, 32.37]
Resident care (including reinstruction and remotivation of the NH)	1391.45	20.46 [13.79, 31.05]
Materials	337.12	4.96 [0.51, 6.42]
Sum	**6980.4**	**102.65**

The control group exhibited the highest probability of being the most cost-effective, with a 100 % probability at a willingness-to-pay (WTP) threshold of 0 Euro. This probability remained consistently high, reaching a plateau at 92 % at a WTP threshold of 270 Euro (Fig. 3c).

4. Discussion

Oral health has been found to be poor among NH residents, particularly in those with high degrees of dependency. OHrQoL is associated with oral health, but also a range of further factors, and may be affected by dental clinical and behavioral interventions. Providing dental care to NH residents may improve OHrQoL and further health, while there is extremely limited data on the health economic implications of providing care and, generally, on the cost-effectiveness of interventions targeting NH residents' OHrQoL. Available studies focus on professional tooth cleaning in NH, showing the overall costs per resident being limited and

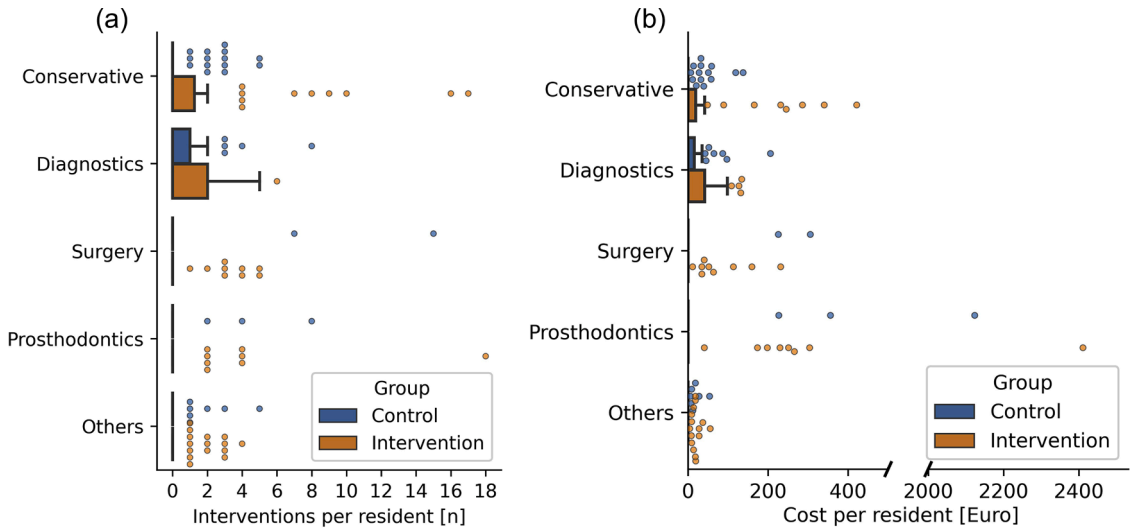

Fig. 2. Boxplot showing number of (a) and cost of (b) utilized dental services per resident. Line: median; Box: 25th and 75th percentile; dots: outliers. Different colors indicate different arms (blue: control, orange: intervention).

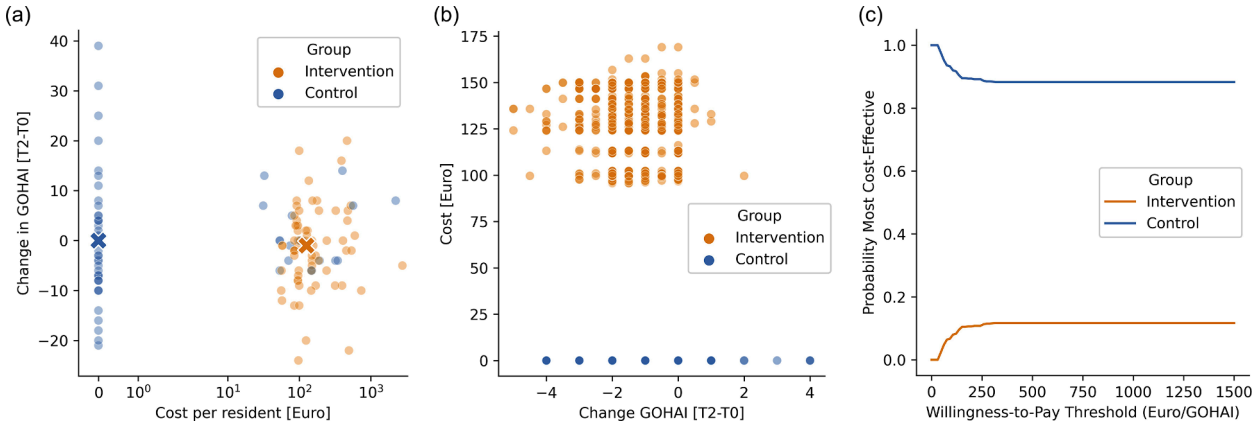

Fig. 3. (a) Scatterplot showing the cost-effectiveness of the respective groups. Centroids (median) are depicted with the marker "x". (b) Scatterplot representing 1000 simulations of the median costs and ADD-GOHAI scores of the bootstrapped dataset. (c) Cost-effectiveness-acceptability of the bootstrapped datasets. While the control arm showed a likeliness of being cost-effective of 91.4 % at the 1500 Euro threshold level, the intervention arm showed a likeliness of being cost-effective of 8.6 % at this threshold.

driven by costs for staff [21], and further highlighting that these costs may be economically worthwhile if further health effects, for example for preventing NH-acquired pneumonia, are considered [22,23]. Moreover, compared with providing care in professional dental settings, domiciliary dental care has been found cost-effective given the reduced need for expensive transportation of NH residents [24].

The present study assessed the economic impact of a complex intervention targeting nursing staff, their provision of oral care, but also their attitudes towards oral health in general, via regular reinstruction and remotivation by DAs. Our analysis reflects on both, the costs of the intervention and the sequels emanating from its implementation with regards to services utilization and servicing patterns. Our control group was the standard of care. Notably, and given the COVID-19 pandemic, our sample size was considerably smaller than anticipated (see below). Based on this sample and over the 13-months trial period, we found the intervention to not improve OHrQoL and to worsen (general) HrQoL. Here, the worsened HrQoL can at least partially be explained by a regression to the mean effect, where a high EQ-5D summary index at T0 was significantly associated with a decrease in HrQoL at T2 and vice versa. With median values of 0.73 (intervention arm) and 0.64 (control arm) at T0, HrQoL in the control arm was particularly low at T0 compared to a representative German population sample with 3 or more medical conditions (mean: 0.71, standard-deviation: 0.28) [25].

We also found the DMFT index, a clinical marker of caries experience and tooth loss, to remain stable in both groups, largely as it was already extremely high in both arms (in median, all relevant teeth had fillings, caries or were lost at baseline already), and hence unlikely to measurably change over the 13-months trial period. Our findings require more in-depth discussion.

The lack of a measurable health benefit and the obvious costs coming with any intervention upfront may, at first glance, be perceived as resulting in a low cost-effectiveness automatically, rendering this analysis only limitedly useful. Notably, however, the intervention itself may affect service utilization, as staff and residents are made aware of oral health and oral health problems, as well as the availability of outreach dental care. Moreover, it may also change servicing patterns, with early attention to dental problems like caries or periodontitis possibly translating into more conservative care, which has been shown to save costs during follow-up as fewer prosthetic or surgical interventions are required [26]. A detailed analysis (see supplementary) of our data highlighted that the largest relative cost increase for dental care in the intervention group was for conservative interventions (increase over 3-fold) as well as diagnostics (almost 2-fold), confirming this assumption.

Overall, our data demonstrate that care intensity in the intervention arm generally increased, leading to higher costs. While this, together with the obvious generation of costs for the intervention itself, will yield a negative cost-effectiveness, such increased care intensity may nevertheless be desired, as it may translate into better oral health, which in turn may affect general health (reduced risk of pneumonia, better control of diabetes mellitus) and thereby even yield positive cost-effectiveness [23]. Unfortunately, based on the obtained health outcomes, our trial could not confirm such better oral or general health. Moreover, it should be highlighted that the obtained subjective and self-reported measures of quality of life might have yielded limited insights for subjects with cognitive impairments, as has been discussed elsewhere [27].

When assessing the intervention costs, it was obvious that traveling times for the DAs were the largest driver of costs. This was followed by costs for staff organizing the visit and spending time in the NH itself for assessing residents and reinstructing and remotivating NH staff. Notably, the cost for the latter aspects – the core of the intervention – were overall limited, constituting only 10 % of the overall costs. Material costs were of subordinate importance, too. From our data, it becomes obvious that cost-effectiveness improvements of any such interventions are likely when costs for travel could be reduced. Notably, in the present evaluation, these costs can be partially attributed to the study itself, which has led to considerable distances to be overcome by each DA. This is less likely to occur in a realistic local servicing model. Improving the effectiveness of the intervention is another driver of cost-effectiveness, but not the focus of the present evaluation. Future studies should assess if tele-visits, tele-reinstruction and tele-remotivation sessions are a valid option.

A major strength of this study lies in the detailed documentation of recruitment barriers and the implementation challenges during remotivation and reinstruction, as revealed in the qualitative process evaluation. Factors such as the pandemic and the nursing care crisis were significant obstacles to resident recruitment and staff readiness for DA visits. These barriers hindered the implementation of the legally required twice-yearly dental prophylaxis for care-dependent individuals in Germany. However, it is essential to question whether the findings of no benefit to OHrQoL and the associated costs in a pandemic setting can be generalized to normal circumstances. Similar interventions in less complex settings have shown more promising results [28–31].

A second strength of the study lies in its nature; there is a dearth of health economic analyses particularly for interventions in vulnerable populations. We used detailed cost estimates, broken down by service types, and further study inherent costs. The economic analysis was the focus of the present evaluation.

Our study has a range of limitations. First, as mentioned, the sample size was much lower than anticipated, leaving some of our analyses underpowered. This limitation inherently increases the likelihood of a Type II error, which is critical to consider when interpreting the results [32]. Whilst the settings in which the study was conducted posed significant hurdles to its execution, they reflect the challenges of NH care and clinical trials conduct during the COVID-19 pandemic (with, for example, one complete NH being excluded during the trial period and the majority of NH aborting enrollment even after initially agreeing to it) [33–35]. A further factor was the extremely high age of our participants (the majority 80–89 years old). Such high age, together with significant co-morbidities, has been found to significantly increase attrition [36]. Notably, we nearly reached the sample size originally estimated to be required to detect the assumed intervention effect, which was significantly adjusted upwards for clustering. Considering that clustering was much lower than anticipated (we only included 7 participants instead of 34 per NH in our final analysis in mean). However, the absent effectiveness difference made it near-impossible to confirm any health intervention effect (see our sample size calculation). Last, our findings were not ambiguous; there were no observable gains in effectiveness coming at – an expected – increase in costs. We further underpin this with bootstrapping – confirming the uncertainty around the resulting cost-effectiveness estimates to be limited.

Second, the employed health outcomes may have been only limitedly able to reflect relevant changes in quality of life or clinical oral health, and future studies should consider OHrQoL particularly tailored to cognitively impaired populations. Moreover, assessing the potential impact of higher servicing intensity on other health aspects should be considered.

Third, our cost estimation used a mix of approaches, involving micro-costing and itemized treatment fees. The former also included distributed costs, where the level of distribution (the NH, the included sample etc.) was not always easy to determine. Moreover, distributing costs will introduce uncertainty to the costs per individual. Fee item costs were only valid for individuals in the public insurance (which is the case for most individuals in Germany and was applicable for our whole sample). Notably, costs may differ for individuals not insured in the public, but the private insurance. Generally, our cost estimates will not necessarily apply to other countries and populations.

In conclusion, and considering these limitations, we found the implemented intervention of DAs reinstructing and remotivating nursing staff towards oral health and oral care to not significantly affect oral health and OHrQoL, but to come with considerable intervention costs. Moreover, the intervention led to an increased service utilization and more frequent consumption of dental care, including conservative, prosthetic and surgical services. This, once more, generated significant costs. As a result, the intervention was more costly and not more effective. Using bootstrapping methods, we found the intervention to show an inferior cost-effectiveness ratio in most simulations and to come with low cost-effectiveness-acceptability. DA-led reinstruction did not improve OHrQoL, negatively impacted HrQoL, and increased costs.

CRediT authorship contribution statement

N.F. Nordblom: Writing – review & editing, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **K. Hertrampf:** Writing – review & editing, Project administration, Investigation, Funding acquisition, Data curation, Conceptualization. **S. Habig:** Writing – review & editing, Project administration, Data curation, Conceptualization. **S. Gabelmann:** Writing – review & editing, Project administration, Investigation, Data curation. **P. Schlattmann:** Writing – review & editing, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **H. Orawa:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **G. Meyer:** Writing – review & editing, Project administration, Methodology, Investigation, Funding acquisition, Data curation. **G. Gaßmann:** Writing – review & editing, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **J. Abraham:** Writing – review & editing, Methodology, Investigation, Conceptualization. **L.M. Wobst:** Writing – review & editing, Methodology, Investigation. **F. Schwendicke:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors have no conflicting interests to declare.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jdent.2024.105520.

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