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Miscellaneous

Standardised multidisciplinary rehabilitation improves health-related quality of life and productivity costs in patients with rheumatic, musculoskeletal and other diseases

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A B S T R A C T

Objectives: This study aims to assess changes in health-related quality of life (HRQoL) and productivity costs following rehabilitation.
Methods: This prospective cohort study of rheumatic and musculoskeletal diseases (RMDs) and 7 other groups collected HRQoL EuroQol 5-Dimension 5-Level (EQ-5D-5L) data for 12 months and work absence data for 24 months postrehabilitation. Differences from baseline in quality-adjusted life years (QALYs) and productivity costs were estimated using the area-under-the-curve method and human capital approach, respectively. Results were adjusted for age, gender (biologically), and education.
Results: We included 3192 patients: mean age 53.1 years, 71% female, 42% had RMDs. HRQoL improved for all participants over 12 months, except for neurological and cancer patients. Differences in QALYs from baseline ranged from −0.014 (neurological diseases) to 0.075 (RMDs). Among 2642 employed participants, productivity costs decreased over 24 months, driven mainly by reduced sick leave (largest in cancer €18,110, smallest in neurological diseases €5747). In contrast, productivity costs for severe obesity increased by €11,614. Mean rehabilitation costs ranged from €3072 to €11,674 for cancer and neurological diseases, respectively, and were €7923 for RMDs.
Conclusions: Following rehabilitation, participants improved in HRQoL and reduced productivity costs from baseline, driven mainly by lower sick leave. Randomised controlled trials are needed to confirm the extent to which these improvements are attributable to the rehabilitation.

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WHAT IS ALREADY KNOWN ON THIS TOPIC

- Evidence regarding the health economic consequences of rehabilitation is often inconsistent or limited by incomplete reporting, leaving decision makers without the necessary evidence to prioritise resources effectively across different chronic conditions.

WHAT THIS STUDY ADDS

- In this prospective cohort study, patients with rheumatic and musculoskeletal diseases and most other diagnostic groups demonstrated improved health-related quality of life and reduced productivity costs, primarily driven by a reduction in sick leave. However, outcomes varied by diagnosis, as not all groups showed these favourable trends.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- These results support the continued use of rehabilitation according to updated guidelines and provide real-world data on health and cost trajectories. However, randomised controlled trials are needed to confirm the extent to which the observed improvements are directly attributable to the rehabilitation interventions.

INTRODUCTION

Globally, a third of people are living with health conditions that may benefit from rehabilitation. This proportion will grow as populations age, and more people live with chronic diseases [1,2]. Therefore, healthcare systems must scale up and strengthen rehabilitation services for people with disabilities to improve daily functioning and health-related quality of life (HRQoL) [3]. Rehabilitation services are, however, challenged by limited resources, including competition for resources from other healthcare services. This highlights the need for evidence on the costs and health benefits of rehabilitation to help decision makers prioritise interventions that are cost-effective.

A systematic review addressing a variety of disabilities concluded that although the available evidence is often described as limited, inconsistent, or inconclusive, some rehabilitation interventions were cost-effective or showed cost-savings [4]. Graded activity vs physical therapy, cognitive behavioural therapy vs advice only, and guideline-endorsed treatments of interdisciplinary rehabilitation were cost-effective for back pain patients; self-management education programmes may improve health outcomes at relatively low costs for patients suffering from arthritis, whereas exercise programmes were cost-effective for patients with hip or knee osteoarthritis when quality-adjusted life years (QALYs) was the clinical outcome [4].

Studies document cost-effectiveness when analysing rehabilitation interventions for specific conditions, such as low back pain, arthritis, stroke, cardiovascular diseases, and complex neurological disabilities [5–8]. Commonly reported benefits are a reduction in the use of health care or other resources [9] and an increase in return to work [10]. However, the huge diversity in disability conditions and interventions makes it difficult to estimate the overall cost-effectiveness and cost-benefits of rehabilitation services [11]. The studies are also often limited by underreported interventions and inconsistent health economic evaluations of rehabilitation, despite existing standards for reporting [12,13]. These facts emphasise a persisting need for more knowledge about the health economic outcomes of rehabilitation based on the multidimensional and biopsychosocial standards set by the World Health Organization [14].

Despite extensive resources used for rehabilitation in private centres, no studies have yet evaluated whether such interventions lead to changes in productivity costs.

The overall aim of the present study was to assess changes in HRQoL and productivity costs in patients undergoing standardised and specialised rehabilitation, and to explore variations in these changes across different diagnostic groups.

METHODS

Study design

This was a prospective multicentre cohort study with a longitudinal observational design.

Recruitment

The patients were recruited from 17 of the 50 private Norwegian rehabilitation centres, most of them located in Eastern Norway. The diagnostic groups were rheumatic and musculoskeletal diseases (RMDs), cancer, cardiovascular and neurological diseases, mental health and sensory disorders, severe obesity, and other main diagnoses. More than 3700 participants were included in the period from January 2019 to March 2020. Twelve-month follow-up was completed in June 2021.

Access to rehabilitation in Norway and content of rehabilitation in private specialist centres

Access to rehabilitation in Norway and how multidisciplinary rehabilitation is offered in specialist rehabilitation centres is briefly described in Supplementary Information (SI), page 1, section I.1 and I.2, respectively, including general professional standards for rehabilitation [15–17].

Inclusion and exclusion criteria: informed consent to participate —allocation to diagnostic group

Eligible patients were adults over 18 years who participated in either day or overnight rehabilitation at 1 of 17 centres, had internet access, could provide informed consent, and with adequate proficiency in Norwegian. Patients in outpatient rehabilitation, or with insufficient ability to participate due to severe cognitive impairment or mental disease, were not eligible.

Patients received oral and written information about the study and a formal invitation to participate from a local project coordinator at admission. Time for reflection for consent was adjusted individually. Most patients provided informed consent immediately, and a few within 1 to 2 days.

The main rehabilitation diagnosis was determined after a finalised diagnostic process by the referring medical specialist and grouped according to ICD-10.

Comorbidity was self-reported on the Charlson checklist of 19 conditions at admission [18]. During goal setting and tailoring of the rehabilitation plan, shared decision making secured the patients' priorities, however, always ensuring optimal rehabilitation according to the main diagnosis.

Data collection

The participants filled in data in a web-based portal, which required authentication according to General Data Protection Regulation (GDPR) data-security level 4. Health personnel were available for guidance and training in this process at admission and discharge, and by phone if guidance was needed after discharge. Descriptive data were filled in at admission, and the generic patient-reported outcome measure (PROM) EuroQol 5-Dimension 5-Level (EQ-5D-5L) at admission, discharge, and at 3-, 6-, and 12-month follow-up. Data on work absence were collected from the Forløpsdatabasen-Trygd (FD-Trygd database), (Event Database - Social Security) (Statistics Norway) (26) from 12 months before until 24 months after baseline. This registry covers sick leave periods >16 days, Work Assessment Allowance (WAA), and disability benefits, but excludes short-term sick leave (≤16 days) paid by employers. Prices for the rehabilitation stays were collected from consenting institutions. The study was approved by the data protection officer at Diakonhjemmet Hospital (DS-00040), and registered in Clinical Trials, NCT03764982, at December 5, 2018.

EQ-5D-5L and QALY

HRQoL was measured by the generic PROM EQ-5D, consisting of 2 parts [19]. The first descriptive part assesses health in 5 dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. We used the EQ-5D 5-level version, with 5 response levels from 1 (no problem) to 5 (extreme problems) [20], which produces a 5-digit health state number, for example, 12331. In the second part, the health state descriptions are converted to utility weights using value sets, which represent societal preferences for all possible health state descriptions derived from trade-off methods in a representative sample of the general population. In the present study, we used the Danish value set since no Norwegian value set was available when computing utilities [21]. Utility weights typically range from 0 (death) to 1 (perfect health), although values lower than 0, indicating states worse than death, are also possible. EQ-5D-based utility weights are widely used to compute QALYs in health economic analyses [22]. The calculation of QALYs involves multiplying each time interval by its corresponding utility weight, with the utility weights reflecting the quality of life experienced during the respective time interval. QALYs thereby account for both the quantity of life (remaining life expectancy) and the quality of life [23].

Estimation of difference in QALYs from baseline

Patient-specific QALYs during the 12-month follow-up period were computed using the area-under-the-curve method [24]. To quantify the difference in QALYs from baseline, we subtracted the QALYs assuming constant baseline utility from the observed QALYs. Detailed description of the calculations is provided in SI, section II.1, pages 1-2.

Work absence and productivity costs

We analysed changes within work absence and computed the differences from baseline productivity levels immediately before the initiation of rehabilitation. A subset of participants was included in these analyses, as the retired individuals were excluded.

Work absence

We quantified work absence for each participant by calculating the total number of days absent from work each month, weighted by the medically certified degree registered in the database (eg, 50% disability for 10 days = 5 weighted days). As described in the section Data collection, the calculation included sick leave >16 days, WAA, and disability benefits. Because the specific degree of reduced work capacity is not recorded for WAA, we assumed WAA represented a 100% absence. Further details about the calculation of work absence can be read in SI, section III, page 2.

Estimation of difference in productivity costs from baseline

We employed a human capital approach [25] to estimate productivity costs, a widely used method that values absence from work due to illness with the individual's gross wage. It is important to note that the human capital approach does not depend on the level of disability and sickness benefits specific to a country's welfare system, as these are transactions that do not necessarily reflect the economic value of lost productivity. We calculated productivity costs by multiplying weighted days absent for each participant by their respective average age- and gender-adjusted daily gross income (including both full-time and part-time positions) [26]. To capture the full societal value of lost production, we added 40% to the gross wage to account for social costs (eg, pension, insurance, and taxes), in accordance with Norwegian guidelines for socioeconomic analysis [27]. Income data for the year 2024 were sourced from Statistics Norway [26]. All monetary values were converted from Norwegian kroner (NOK) to euros (€) using the average annual exchange rate for 2024 (1 EUR = 11.63 NOK), as reported by Norges Bank [28].

To calculate the difference in accumulated productivity costs from baseline, we subtracted the expected productivity costs, assuming constant baseline productivity, from the observed productivity costs. Details and formulas for the calculations are provided in SI, section IV, pages 2-3.

Prices for the rehabilitation

Fifteen of the 17 centres stated electronically and anonymously the daily prices in NOK, year 2020, for rehabilitation within the different diagnostic subgroups. The prices were adjusted to 2024 values using the consumer price index (KPI) and then converted to euros (€). Calculation of mean duration, and mean total and daily prices (€) for the rehabilitation in the diagnostic subgroups is described in SI, section V, pages 3-4.

Statistical analyses

Patient characteristics at baseline are presented overall and for each diagnostic group. Categorical variables are presented as frequencies and proportions, while continuous variables are presented as means, medians, and SDs. Missing EQ-5D-5L data were handled by using multivariate imputation by chained equation (MICE) with predictive mean matching, a method known for its good performance across a wide variety of situations [29,30]. MICE assumes data are missing at random (MAR), meaning missingness can be explained by observed variables included in the imputation model. The imputation procedure is described in SI, section VI, page 4.

We fitted linear regression models to assess the relationship between diagnostic groups and the differences in QALYs and productivity costs from baseline, while adjusting for age, gender, and education level. The model specification for differences in QALYs is described in SI, section II.1 and II.2, pages 1-2, in addition to a corresponding model for differences in productivity costs. We computed adjusted mean differences to provide an adjusted estimate of the absolute differences in QALYs and productivity costs from baseline to 12-month follow-up for QALYs, and 24-month follow-up for productivity costs for each diagnostic group, adjusted for age, gender, and educational level. All data management and analyses were performed using R version 4.2.2.

RESULTS

Baseline characteristics

A total of 3192 participants were included in the analysis of the EQ-5D-5L quality of life data. Mean age (SD) was 53.1 (13.6) years, most in the age groups from 40 to 70 years. 71% were female, ranging from 36% in cardiovascular disease to 78% in cancer. In total, 59% were cohabiting/married, 64% had 3 or more additional diseases, and the mean body mass index (SD) was 29.3 (6.9). Daily smokers represented 9%, and 86% had high school or higher education. Table 1 shows further details on baseline patient characteristics for the overall cohort and each diagnostic group. The patient characteristics for the RMD group were marginally different compared to the overall group.

Observed and imputed EQ-5D-5L utility weights

Overall, the mean (SD) observed EQ-5D-5L utility weights improved from 0.65 (0.25) to 0.71 (0.25) from baseline to 12-month follow-up. RMD improved from 0.57 (0.28) to 0.68 (0.27). Complete case values of EQ-5D-5L at 3-, 6-, and 12 months follow-up for the whole sample, and for the 8 diagnostic groups, are presented in Table 2, together with a summary of missing data. The observed EQ-5D-5L utility weights are graphically illustrated in Supplementary Figure S1, page 5.

Multiple imputed EQ-5D-5L utility weights

The imputation procedure and diagnostics, including trace plots, Supplementary Figure S2, page 6, and the distribution of observed and imputed values, Supplementary Figure S2, page 7, are provided in SI, section VI.1 and VI.2, pages 4-7. Diagnostic checks indicated good convergence of the imputation algorithm, and the distributions of imputed and observed values were similar.

Figure 1 illustrates the multiple imputed EQ-5D-5L utility weights at baseline, discharge, and 3-, 6-, and 12-month follow-up. The imputed values follow similar trends as the observed values, as seen in Supplementary Figure S1, page 5.

Differences in QALYs from baseline to 12-month follow-up

The multiple linear regression analysis examined factors associated with differences in QALYs from baseline to the 12-month follow-up. Higher age was significantly associated with an increase in QALYs from baseline, as was higher education compared to elementary school. Supplementary Table S1, page 8, presents further details.

Table 3 provides the adjusted mean differences in QALYs from baseline, adjusted for age, gender, and education. Patients with RMD had the greatest increase in QALYs (95% CI) from baseline of 0.075 (0.062, 0.088), closely followed by mental health disorders. Patients with cancer and neurological disease had small reductions in QALYs.

Work absence and productivity costs

Baseline patient characteristics

A total of 2642 working individuals were included in the study population subset, excluding retired individuals. Baseline patient characteristics, presented in Supplementary Table S2, pages 9-10, were similar to the overall study population.

Work absence

Figure 2 graphically depicts the overall absence rates before and after rehabilitation. An increase in work absence rates was observed in the period leading up to and through rehabilitation, followed by a drop below baseline levels shortly after discharge in all subgroups, except for severe obesity. The neurological diseases group had the highest absence rates both before and after rehabilitation.

Figure 3 illustrates absence rates by type before and after rehabilitation. A reduction in sick leave and a rise in WAA were observed during the first 10 months after rehabilitation for all diagnostic groups, except for in severe obesity. The decline in overall absence rates to below baseline levels, as shown in Figure 2, appears to be driven primarily by a sharp reduction in sick leave. Disability benefits increased in all groups across the 36-month follow-up period, and WAA showed a declining trend starting approximately 10 months after baseline, except in the severe obesity group.

Productivity costs

Productivity costs before and after rehabilitation display similar trends to those observed for work absence rates in Figure 2, and are shown in Supplementary Figure S4, page 11.

Factors associated with differences in productivity costs

Supplementary Table S3, page 12, presents the results of the multiple linear regression analysis examining the factors associated with the difference in productivity costs from baseline over 24-month follow-up. Details are described in the associated text in SI, page 13.

Table 4 provides the adjusted mean differences in productivity costs from baseline over a 24-month follow-up period, adjusted for age, gender, and education. Except for patients with severe obesity, all diagnostic categories were associated with a decrease in productivity costs, with the largest decrease observed in patients with cancer. Similar results were observed over the 12-month follow-up period, with lower productivity costs in all diagnostic groups except for severe obesity. Supplementary Table S4, page 14, shows detailed regression results and adjusted mean differences.

Rehabilitation prices

Mean duration of rehabilitation and total and daily prices (€) in the diagnostic subgroups are shown in Table 5. The neurological disease group had the longest mean duration and the highest total and daily price of the rehabilitation. The cancer group had the shortest mean duration and the lowest total price. The severe obesity and cardiovascular groups had the lowest daily prices.

Table 1
Baseline patient characteristics overall and in the 8 diagnostic groups

Characteristics	Overall N = 3192	RMD[a] N = 1327	Cancer N = 788	Cardiovascular disease N = 97	Neurological disease N = 354	Severe obesity N = 279	Sensory disorders N = 122	Mental health disorders N = 65	Other main diagnosis N = 160
Age, mean (SD)	53.1 (13.6)	53.4 (13.7)	56.8 (11.1)	62.5 (12.9)	49.1 (15.2)	46.3 (12.2)	53.1 (10.9)	47.9 (9.5)	49.4 (16.3)
Age group, no. (%)									
<30	190 (6%)	60 (5%)	16 (2%)	3 (3%)	51 (14%)	35 (13%)	2 (2%)	3 (5%)	20(13%)
30 to 39	324 (10%)	151 (11%)	30 (4%)	3 (3%)	46 (13%)	45 (16%)	13 (11%)	9 (14%)	27 (17%)
40 to 49	688 (22%)	317 (24%)	135 (17%)	10 (10%)	68 (19%)	71 (25%)	27 (22%)	26 (40%)	34 (21%)
50 to 59	951 (30%)	375 (28%)	274 (35%)	18 (19%)	95 (27%)	93 (33%)	46 (38%)	19 (29%)	31 (19%)
60 to 69	633 (20%)	225 (17%)	230 (29%)	30 (31%)	61 (17%)	31 (11%)	24 (20%)	8 (12%)	24 (15%)
70 +	406 (13%)	199 (15%)	103 (13%)	33 (34%)	33 (9%)	4 (1%)	10 (8%)	0 (0%)	24 (15%)
Gender, no. (%)									
Female[b]	2259 (71%)	1004 (76%)	614 (78%)	35 (36%)	216 (61%)	168 (60%)	64 (52%)	50 (77%)	108 (68%)
Comorbidities, no. (%)									
None	0 (0%)	0 (0%)	0 (0%)	0(0%)	0 (0%)	0 (0%)	0 (0%)	0(0%)	0(0%)
1 to 2	1143 (36%)	420 (32%)	294 (37%)	25 (26%)	144 (41%)	105 (38%)	66 (54%)	36 (55%)	53 (33%)
3 to 4	1416 (44%)	606 (46%)	358 (45%)	47 (48%)	150 (42%)	122 (44%)	44 (36%)	21 (32%)	68 (42%)
5 or more	633 (20%)	301 (23%)	136 (17%)	25 (26%)	60 (17%)	52 (19%)	12 (10%)	8 (12%)	39 (24%)
BMI, Mean (SD)	29.3 (6.9)	29.3 (5.8)	27.0 (5.1)	28.5 (5.3)	26.8 (5.3)	41.6 (6.5)	26.7 (4.2)	28.0 (5.7)	28.1 (7.2)
Unknown	51	24	3	1	9	1	4	1	8
Smoking, no. (%)									
Never	1337 (42%)	528 (40%)	358 (46%)	44 (45%)	143 (41%)	117 (42%)	53 (43%)	26 (40%)	68 (43%)
Previous/sporadic	1565 (49%)	639 (48%)	405 (52%)	48 (49%)	172 (49%)	132 (47%)	66 (54%)	30 (46%)	73 (46%)
Daily	279 (9%)	155 (12%)	23 (3%)	5 (5%)	38 (11%)	30 (11%)	3 (2%)	9 (14%)	16 (10%)
Unknown	11	5	2	0	1	0	0	0	3
Marital status, no. (%)									
Cohabiting/married[c]	1889 (59%)	742 (56%)	540 (69%)	59 (61%)	185 (53%)	168 (60%)	98 (80%)	17 (26%)	80 (51%)
Unknown	7	2	0	0	3	0	0	0	2
Education, no. (%)									
Elementary school	444 (14%)	225 (17%)	81 (10%)	13 (13%)	48 (14%)	31 (11%)	5 (4%)	8 (12%)	33 (21%)
High school	1265 (40%)	586 (44%)	245 (31%)	37 (38%)	138 (39%)	141 (51%)	39 (32%)	22 (34%)	57 (36%)
Higher education	1472 (46%)	512 (39%)	460 (59%)	47 (48%)	168 (47%)	105 (38%)	77 (64%)	35 (54%)	68 (43%)
Unknown	11	4	2	0	0	2	1	0	2

BMI, body mass index; RMD, rheumatic and musculoskeletal disease.
[a] Subgroups (%): musculoskeletal disorders (90%), rheumatoid-, or osteoarthritis (10%).
[b] Other participants stated their gender as male.
[c] Other participants stated their marital status as single.

Table 2

Observed EQ-5D-5L utility weights and proportion of missing data at baseline, discharge, and follow-up at 3-, 6-, and 12 months

Characteristic	Overall	Baseline	Discharge	3 mo	6 mo	12 mo
Missing or incomplete, no. (%)	4655 (29%)	80 (2.5%)	1648 (52%)	804 (25%)	1031 (32%)	1092 (34%)
Complete cases, no. (%)	11,305 (71%)	3112 (97%)	1544 (48%)	2388 (75%)	2161 (68%)	2100 (66%)
EQ-5D-5L value, mean (SD)	0.69 (0.26)	0.65 (0.27)	0.72 (0.23)	0.71 (0.25)	0.70 (0.27)	0.71 (0.25)
EQ-5D-5L values, mean (SD)						
RMD	0.64 (0.27)	0.57 (0.28)	0.68 (0.25)	0.67 (0.27)	0.66 (0.28)	0.68 (0.27)
Cardiovascular disease	0.74 (0.25)	0.68 (0.28)	0.78 (0.22)	0.79 (0.21)	0.73 (0.27)	0.74 (0.26)
Cancer	0.77 (0.20)	0.76 (0.19)	0.80 (0.17)	0.78 (0.19)	0.77 (0.21)	0.78 (0.20)
Neurological disease	0.61 (0.28)	0.61 (0.27)	0.64 (0.26)	0.61 (0.28)	0.59 (0.29)	0.60 (0.28)
Severe obesity	0.77 (0.23)	0.74 (0.22)	0.80 (0.19)	0.78 (0.22)	0.77 (0.25)	0.77 (0.27)
Sensory disorders	0.77 (0.21)	0.74 (0.23)	0.84 (0.13)	0.78 (0.21)	0.77 (0.24)	0.78 (0.19)
Mental health disorders	0.67 (0.24)	0.59 (0.25)	0.68 (0.25)	0.71 (0.21)	0.71 (0.25)	0.74 (0.18)
Other main diagnosis	0.66 (0.26)	0.60 (0.28)	0.72 (0.24)	0.68 (0.24)	0.65 (0.27)	0.67 (0.25)

RMD, rheumatic and musculoskeletal disease.

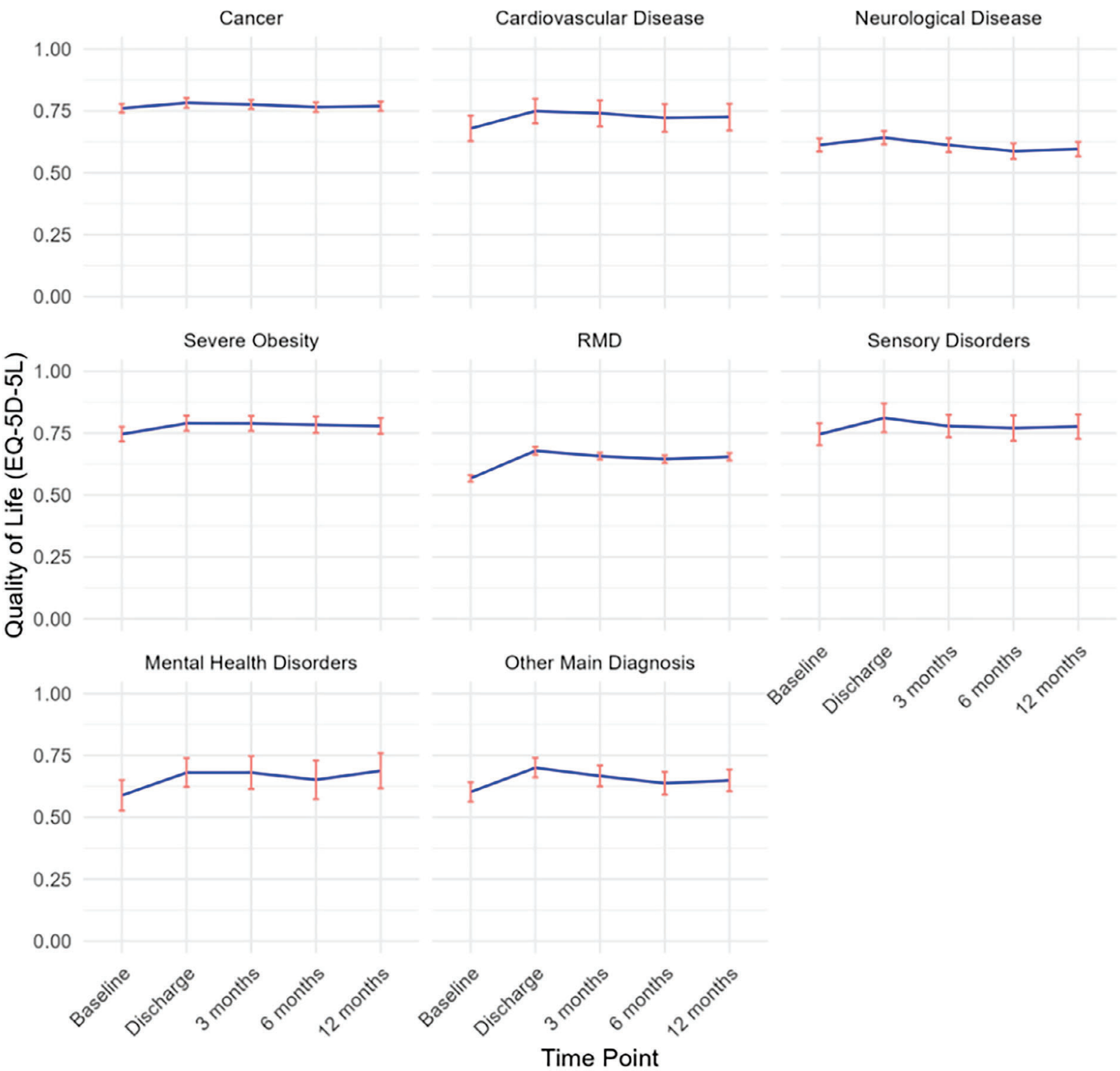

Figure 1. Multiple imputed EQ-5D-5L utility weights at baseline, discharge, and at 3-, 6-, and 12-month follow-up. RMD, rheumatic and musculoskeletal disease.

Table 3
Mean difference in QALYs from baseline, adjusted for age, gender, and education

Diagnosis	Estimate	SE	95% CI
RMD	0.075	0.007	0.062, 0.088
Cancer	−0.009	0.008	−0.026, 0.007
Cardiovascular disease	0.031	0.022	−0.012, 0.074
Neurological disease	−0.014	0.012	−0.037, 0.009
Severe obesity	0.038	0.013	0.013, 0.063
Sensory disorders	0.019	0.019	−0.019, 0.057
Mental health disorders	0.074	0.028	0.019, 0.129
Other main diagnosis	0.049	0.018	0.014, 0.083

QALY, quality-adjusted life year; RMD, rheumatic and musculoskeletal disease.

DISCUSSION

This was a multicentre prospective cohort study, investigating changes in HRQoL and productivity costs during rehabilitation and follow-up of a large study population representing RMD, (42%), and a broad spectrum of other diseases. The patients were recruited from one-third of Norwegian private specialist rehabilitation centres.

Development in HRQoL and QALYs

All diagnostic groups, except for neurological diseases and cancer, demonstrated an increase in QALYs from baseline until 12-month follow-up. Higher age and higher education were significantly associated with larger increases in QALYs from baseline, with the latter as the most influential. Higher education is associated with higher health literacy, which may explain some of the larger increases in QALYs in this subgroup [31,32]. Higher age is usually associated with greater comorbidity and severity. However, the patients improving most in HRQoL were middle-aged and still not at a high age. They suffered from RMD, the largest disease group. Patients in groups with smaller improvements in HRQoL or reductions were generally younger.

The RMD patients had the largest QALY improvement, 0.075, which might appear modest. However, given the baseline EQ-5D-5L RMD index of 0.57, the improvement was 13.2%. A systematic review revealed that minimally important difference (MID) scores may decrease with increasing baseline scores, recommending baseline score-adjusted MIDs, which for EQ-5D-5L ranged from 0.01 to 0.41 [33]. The fall in sick leave for RMDs from about 30% at baseline to about 8% at 12-month follow-up (Fig 3) might well have mirrored the functional improvements in EQ-5D-5L (Table 2). It is common in health economic evaluations to consider a lifetime horizon to fully capture the long-term benefits of interventions [23]. We computed QALYs based on the 12-month follow-up data. Therefore, if these improvements in EQ-5D-5L scores are sustained over the long term, they could result in a much larger lifetime gain in QALYs from baseline.

The patients with RMD suffering from inflammatory diseases were optimally medicated or in stable phases of their diseases. The

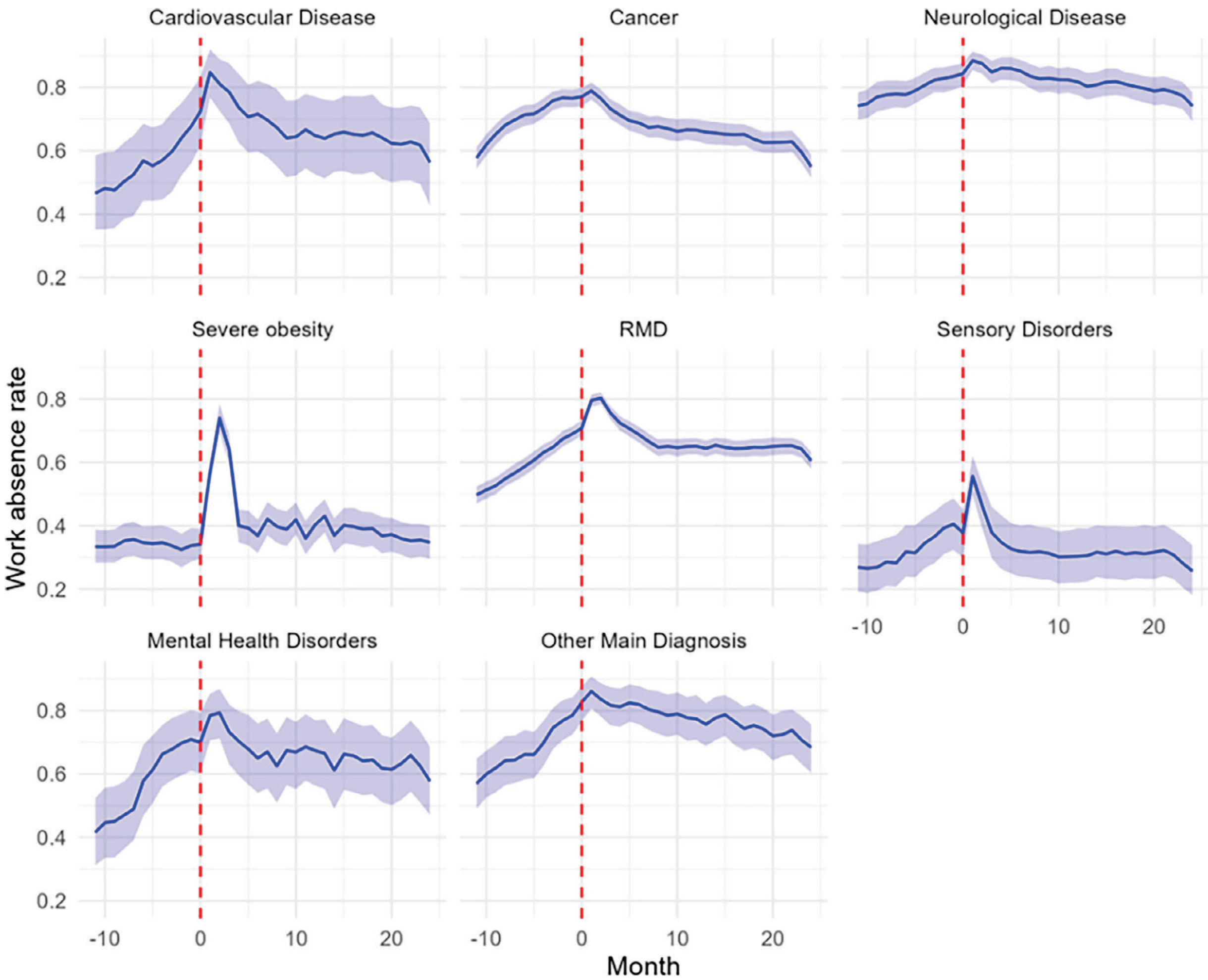

Figure 2. Work absence rates before and after baseline, reflecting the degree of absence from full-time work. The red line indicates baseline, the time point immediately before rehabilitation. RMD, rheumatic and musculoskeletal disease.

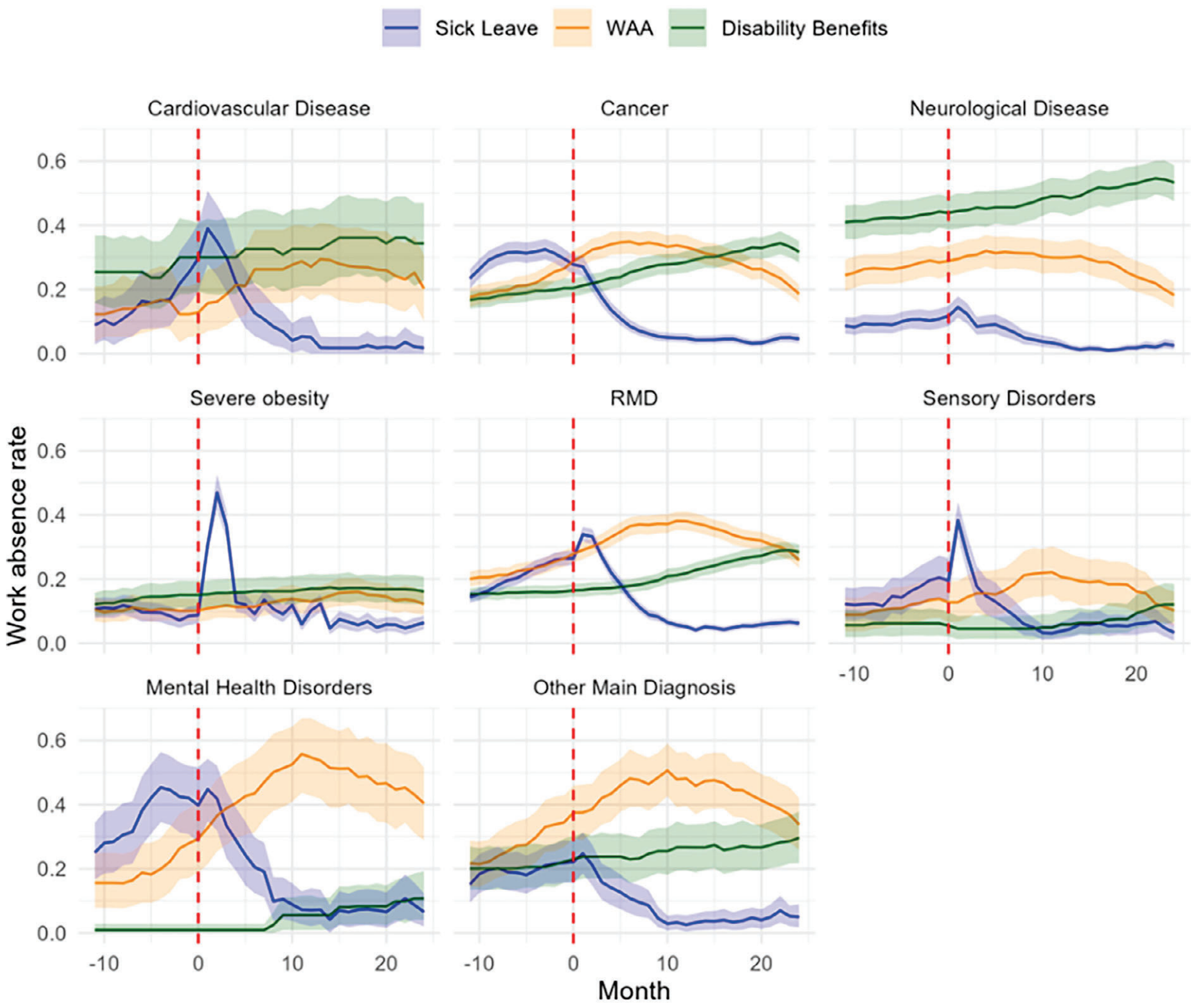

Figure 3. Work absence rates by absence type before and after rehabilitation, reflecting the degree of absence from full-time work. The red line indicates baseline, the time point immediately before rehabilitation. RMD, rheumatic and musculoskeletal disease; WAA, work assessment allowance.

Table 4

Mean difference in productivity costs (€) from baseline until 24-month follow-up, adjusted for age, gender, and education

Diagnosis	Estimate	SE	95% CI
RMD	−8037	1869	−11,703, −4371
Cancer	−18,110	2487	−22,987, −13,233
Cardiovascular disease	−6886	7303	−21,206, 7434
Neurological disease	−5747	3247	−12,114, 619
Severe obesity	11,614	3472	4806, 18,423
Sensory disorders	−7060	5454	−17,755, 3635
Mental health disorders	−7494	6910	−21,045, 6056
Other main diagnosis	−12,489	5013	−22,319, −2660

RMD, rheumatic and musculoskeletal disease.

RMD group was therefore well prepared to benefit from the rehabilitation, which may have contributed to the QALY improvements.

The study centres worked according to updated systematic reviews of guidelines [34,35] and the WHO Package of interventions for rehabilitation for musculoskeletal conditions [36], such as health education, adapted exercise, and cognitive behavioural therapy, in addition to the specific disease interventions.

Cancer survivors report unmet needs in informational, psychological, physical, and functional domains [37]. The EQ-5D questionnaire captures several of these domains, and statistically and clinically important improvements are reported by patients with cancer after interdisciplinary rehabilitation [38]. However, the present study results did not support this.

Changes in work absence and productivity costs

Overall, there were declining trends in work absence rates and productivity costs following rehabilitation, except for in the severe obesity group, in which productivity costs increased due to a temporary increase in sick leave during rehabilitation, and the work absence rate changed marginally during the 36-month study period. A systematic review and meta-analysis concluded, however, that nonpharmacological interventions among RMD patients have small effects on work participation and rather depend on contextual factors [39].

The analyses revealed reductions in productivity costs from a societal perspective in both the 12-month and 24-month follow-up periods. Female gender was, however, significantly associated with increased productivity costs, which is well documented internationally [40]. The results of associations between higher age and higher education to decreases in productivity costs are also confirmed in the literature [41,42]. Analyses from another RehabNytte substudy showed that higher education was associated with a statistically significant increase in work ability compared to lower education [43].

Table 5
Mean duration of, and total and daily prices (€) for the rehabilitation in the diagnostic subgroups

Diagnostic group	N	Mean duration (d)	Mean total price (€)	Mean daily price (€)
RMD	1870	23	7923	344
Neurological disease	477	28	11,674	417
Sensory disorders	152	21	7744	369
Cancer	851	10	3067	307
Severe obesity	236	24	5154	215
Cardiovascular disease	75	21	5723	273
Mental health disorders	74	–	Prices missing	–
Other main diagnoses	244	22	7602	346

RMD, rheumatic and musculoskeletal disease.

The decrease in productivity costs was largely driven by a reduction in sick leave. In contrast, disability rates generally continued to rise postrehabilitation, approximately 10%, along with an initial rise in WAA during the first 10 months postrehabilitation. These trends suggest that the impact of rehabilitation may differ across different types of work absence, possibly being more influential in reducing temporary sick leave as opposed to long-term disability, indicating that rehabilitation should be offered earlier in the sick leave process than is currently the practice. We calculated productivity costs using the human capital approach based on average age- and gender-specific wages, which is common practice in health economic evaluations to ensure consistency and generalisability [25]. Furthermore, this approach ensures equity by not prioritising health improvements in high-income groups over low-income groups. However, using average wages does not capture wage differences between different occupations, though we adjusted for education level to account for socioeconomic differences. Furthermore, our reliance on registry data means that we did not have information on presenteeism (reduced productivity while at work), potentially leading to an underestimation of total productivity costs.

The cancer group had the largest decrease in productivity costs from baseline. It is likely that the effect of the cancer treatment itself plays a major role in this reduction, given the negative QALY results in this study.

A degree of 100% WAA was chosen for all participants, as detailed data on this benefit were not available. This may have led to an overestimation of productivity costs compared to actual levels. However, according to Norwegian Labour and Welfare Administration (NAV) statistics, about 75% of individuals in WAA are covered by 100%, and the average working capacity in the remaining 25% is 36% [44]. This means that more detailed WAA data would probably not significantly change the results. Moreover, since the overestimation would apply to both baseline and observed productivity costs, the difference between these costs—which is our primary interest—might be less affected by this assumption.

Rehabilitation prices

The number of people living with conditions that may benefit from rehabilitation is substantial, and prospects indicate continuously increasing numbers [1,2]. Rehabilitation prices rise with increasing duration and care needs (typically neurology) and fall with group-, short-, day-, and partially digital interventions (typically cardiovascular, cancer, severe obesity). Given the improvements in HRQoL, the reasonable rehabilitation prices, and the reductions in productivity costs for most diagnostic groups, we would argue that prioritising rehabilitation contributes significantly to keeping health expenses down.

Study strengths and limitations

The large study population, the multicentre design, and follow-up periods of 12 months for QALYs and 24 months for productivity costs contributed to the strengths of this study. Also, the rehabilitation for RMD and the other conditions was performed according to updated knowledge and specific guidelines [4,7,8,34,35,36], which should indicate positive outcomes. However, important limitations are the observational and non-randomised design, and potential uncontrolled confounders, such as effects of possible additional treatments, natural disease progression, and placebo effects.

Eighty-seven percent of the 3192 study participants provided data at baseline and at least 1 follow-up point. To handle missing data, we used MICE. MICE reduces bias compared to complete case-analysis and appropriately accounts for the uncertainty associated with missing values [29].

A strength of the study was the complete work absence data obtained from the national registry for all participants. However, a limitation is the lack of data on short-term sick leave (≤16 days), which is covered by employers. This likely leads to an underestimation of total productivity costs. Yet, since the study population consists of patients with chronic conditions referred to specialist rehabilitation, long-term absence is considered the primary driver of productivity costs in this cohort. Furthermore, this limitation applies consistently across all groups and time points.

Our analysis compared follow-up data to a constant baseline level of HRQoL and productivity. This is likely a conservative assumption, as productivity costs were generally increasing before rehabilitation, suggesting that extrapolating the prerehabilitation trend as the baseline would have resulted in larger estimated improvements. Given the known correlation between productivity costs and utility values [45], a similar conservative effect is likely for the QALY estimates.

The study participants were predominantly middle-aged and overweight women, cohabiting, higher educated, most non-smokers, in the chronic phase of their disorder and with 3 or more comorbidities. These characteristics may have limited the generalisability of the study results. However, they correlate well to the national statistics for Norwegian specialist rehabilitation centres (63% female, age 53, about 50% RMDs) [46].

Data collection was across the COVID-19 pandemic. This meant more distanced contact both with personnel and other patients, and probably generally more negative moods, which may have impacted the rehabilitation results negatively.

Conclusions

In this study, we assessed changes in HRQoL and productivity costs in patients undergoing specialist rehabilitation. We found that patients with RMDs and most other subgroups showed improvements in HRQoL and reductions in productivity costs compared to baseline levels. The reduction in productivity costs appears to be primarily driven by a decrease in short-term sick leave, as rates of long-term disability benefits continued to rise. However, randomised controlled trials are needed to confirm whether these improvements are directly attributable to the rehabilitation.

Competing interests

All authors declare they have no competing interests.

CRediT authorship contribution statement

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Contributors

IJ, RHM, MV, and IK performed material preparation, data collection, and analysis, and wrote the first draft of the manuscript. All authors contributed to the conception and design of the study, commented on previous versions of the manuscript and read and approved the final manuscript.

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Patient consent for publication

Informed consent was obtained before the data collection from all individual participants included in the study.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the data protection officer at Diakonhjemmet Hospital (DS-00040).

Provenance and peer review

Not commissioned; externally peer reviewe.

Data availability statement

In accordance with legal requirements, study data cannot be made publicly available.

Supplementary materials

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