BMJ Public Health

Effect of physical activity counselling on the number of contacts in primary healthcare, specialised healthcare and the related healthcare costs among patients with type 2 diabetes: a register-based evaluation study

Tuula Martiskainen ,[1,2] Marja-Leena Lamidi,[2] Miika Linna,[3,4] Mika Venojärvi,[5] Heikki Tikkanen,[5] Tiina Laatikainen[1,2,6]

To cite: Martiskainen T, Lamidi M-L, Linna M, *et al*. Effect of physical activity counselling on the number of contacts in primary healthcare, specialised healthcare and the related healthcare costs among patients with type 2 diabetes: a register-based evaluation study. *BMJ Public Health* 2023;**1**:e000098. doi:10.1136/bmjph-2023-000098

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjph-2023-000098).

Received 28 March 2023
Accepted 12 September 2023

For numbered affiliations see end of article.

Correspondence to
Dr Tuula Martiskainen;
tuulama@student.uef.fi

ABSTRACT

Introduction This study evaluated the effect of physical activity (PA) counselling on the number of contacts and related costs in primary healthcare (PHC) and specialised healthcare (SHC) among patients with type 2 diabetes (T2D).

Methods The study was carried out in North Karelia, Finland, among PHC clients with T2D in 2016–2018. Altogether, 521 patients participated in the counselling. In total, 1382 sex, age, time of diagnosis and intervention time-matched controls were used to assess the effect of the intervention. Information on outpatient nurse and physician appointments in PHC and SHC was collected from October 2016 to December 2019. The reason for the visit was identified with the recorded main diagnosis using both International Classification of Diseases-10 and International Standard Classification of Primary Care-2 diagnoses. Unit costs of SHC visits were based on average diagnosis-related group costs and for PHC unit costs for appointments for physicians, nurses and physiotherapists on the national price list.

Results The number of physician and nurse appointments in the PHC related to T2D decreased in the intervention group and increased in the control group with statistically significant differences in mean annual changes between groups ($p=0.010$ and $p<0.001$, respectively). In PHC, the number of physician appointments related to musculoskeletal disorders decreased in the intervention group and increased in the control group with a statistically significant difference between groups ($p<0.001$). In the intervention group, T2D-related costs of appointments per person-year in PHC decreased, while an increase was observed in the control group ($p<0.001$).

Conclusions This study shows that PA counselling in PHC offers significant benefits in the treatment of patients with T2D by also improving the use of the resources in healthcare. The PA counselling reduced the number of other appointments and costs of appointments per person-year.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Patients with type 2 diabetes (T2D) use a substantial amount of healthcare services. Among primary care contacts, nurse contacts are the most common.

⇒ Previous studies have shown that reductions in body mass index and haemoglobin A1c are correlated with reductions in healthcare spending among patients with T2D.

WHAT THIS STUDY ADDS

⇒ Physical activity (PA) counselling in primary healthcare (PHC) offers significant benefits in the treatment of patients with T2D by also improving the use of the resources in healthcare.

⇒ The PA counselling reduced the number of other appointments and thus costs of the health service use.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study carried out in 'real-world' setting provides valuable additional information on the feasibility of implementation research in PHC and how electronic patient information systems can be used as a source of research data.

⇒ PA counselling improves the treatment outcomes and supports patients, reduces the need for other healthcare appointments and thus increases cost savings and cost-effectiveness of healthcare.

INTRODUCTION

According to the WHO, diabetes will be the seventh-leading cause of death in 2030.[1] The majority of patients with diabetes suffer from type 2 diabetes (T2D), which is largely preventable as caused strongly by obesity and physical inactivity.[2] A sedentary lifestyle, unhealthy diet and urbanisation are strongly associated with the prevalence of T2D in adults.[3] Despite the

increasing number of drugs available and various guidelines on the management of T2D, an expressive number of patients continue with the disease uncontrolled.[4] Many studies have shown that proper diet and physical activity (PA), considered as non-pharmacological treatments of T2D, effectively improve the glycaemic control and other metabolic outcomes in patients with T2D.[5–7] People with T2D should engage regularly with moderate or vigorous intensity PA.[7] Despite these noted benefits, adults with T2D are less likely to engage in regular PA than the general adult population.[8] Therefore, it is important to invest in improving lifestyles that can promote health and maintain glycaemic control in patients with T2D.

Healthcare organisations are encouraged to introduce healthy lifestyle promotion in routine practice.[9] Primary healthcare (PHC) has been identified as the setting that can offer continuous and comprehensive lifestyle promotion to patients with health-risk behaviour.[10 11] Implementing lifestyle counselling in clinical practice has been shown to be feasible, cost-effective[12] and acceptable among healthcare professionals and patients.[13] Many translational 'real-world' diabetes prevention programmes have yielded positive results, but they have been on a small-scale. The resources needed for implementation of many interventions in a 'real-world' situation are quite modest, but can be efficient and profitable.[14]

Recently diagnosed patients with T2D use a substantial amount of healthcare services, especially during the first year after diagnosis. Among primary care contacts, nurse contacts are the most common.[15] Wikström *et al*[16] found in their study that patients with T2D who had good treatment control had less healthcare contacts compared with those who were not within the target level of haemoglobin A1c (HbA1c). PHC contacts provide opportunities to positively influence and support healthy behaviours, optimise treatment plans and promote self-management to patients with T2D.[17] Kauppila *et al*[18] have found that previous T2D drop-outs with significant improvement in their glycaemic control seemed to have more frequent visits or telephone contacts with healthcare professionals than those who did not show improvement in their glycaemic control. Previous drop-outs who had poor glycaemic control may especially benefit from frequent controls.[18]

The purpose of healthcare is to improve the health of populations. However, formal medical care is only one of many alternatives for improving health.[19] Behavioural medicine is in a unique, but underappreciated, position to contribute to an understanding of how best to deliver high-quality, cost effective healthcare and promote the public's health across a broad range of interventions.[20] Roux *et al*[21] have assessed in their study the cost-effectiveness of population-wide strategies to promote PA in adults and followed disease incidence over a lifetime. According to their study, all the evaluated PA interventions reduced disease incidence and were cost-effective compared with other well-accepted preventive strategies. PA interventions offered good value for money.[21]

We have previously reported that PA counselling in PHC, even with a modest increase in exercise, offers significant benefits in the treatment of T2D and can contribute to the glucose control of individuals with T2D.[22] However, the evidence on the effects of PA counselling of patients with T2D on healthcare contacts and related cost-effectiveness is limited. Previous studies have shown that reductions in body mass index (BMI) and HbA1c[23 24] correlate with reductions in healthcare spending among patients with T2D.[12] All interventions that improve the quality of care and glycaemic control may have longer-term impact and thus increase value in healthcare by improving health outcomes and reducing costs.[25] The aim of this study is to evaluate the effect of PA intervention carried out as a part of PHC services of patients with T2D on the number of contacts and costs of appointments in PHC and specialised healthcare (SHC).

METHODS

Participants

All patients with T2D were offered the opportunity to participate in a PA counselling programme in the Siun sote healthcare region in North Karelia, Finland, from October 2016 to December 2018. Especially patients with very little PA were referred for PA counselling by nurses, physiotherapists and physicians. The follow-up time was from October 2016 to December 2019. Altogether, 546 patients were referred to the PA educator of whom 521 participated in the counselling. In total, 1382 sex, age, time of diagnosis and intervention time-matched controls extracted from patient records were used to see the effect of the intervention. The PA counselling was provided by PA educators flexibly according to the patients' needs and thus the number of counselling sessions varied. On average, patients visited the PA educator three times.[22 26] Also, the type and intensity of PA what the patients were advised to do varied as counselling was tailored according to patients' needs and health status.[22]

Measurements and appointments

Information on all physiological laboratory measurements and number of appointments was retrieved from electronic health records (EHRs) retrospectively. For both intervention and control group participants, height (cm) and weight (kg) were measured and blood samples for HbA1c collected in health services, following the current practice in the follow-up of patients with T2D. The turbidimetric inhibition immune analysis method (TINIA) was used to analyse HbA1c. All samples were analysed in the same regional laboratory. Outpatient visits, that is, appointments to physicians, nurses and physiotherapists in PHC and SHC, were analysed starting from October 2016 to the start of the intervention and 3 months after the start of the intervention until the end of the follow-up, December 2019. The reason for the visit was identified using the recorded main diagnosis according to specific International Classification of

Diseases (ICD)-10 diagnoses and International Standard Classification of Primary Care (ICPC-2). Appointments with an ICD-10 code E11 and ICPC-2 code T90 were regarded as T2D-related visits. For musculoskeletal disorders (MSD) the visits with following ICD-10 codes, which were the most common diagnoses related to musculoskeletal diseases and symptoms were the following: G44.2, G55.2, M15, M16, M17, M19.0, M24.5, M24.6, M25.2, M25.3, M25.5, M25.6, M25.7, M40, M41, M43.0, M45, M47, M48, M50, M51, M53, M54, M62.3, M62.4, M62.5, M75, M79.6, M79.7, M79.8, M79.9, M80.0, M81.0, M85.8, R25.2, R26.8, R29.8, S33.1 and S33.2; and the ICPC-2 codes L01–L08, L10, L13–L15, L18–L20, L28, L29, L83–L86, L89–L92, L95 and L99 were taken into account.

Healthcare costs

The unit costs of SHC visits were based on the average diagnosis-related group (NordDRG) costs. The NordDRG patient grouping definitions are based on the ICD 10th revision (ICD-10) codes and the Finnish version of the Nordic Classification of Surgical Procedures codes for diagnostic and treatment procedures. The cost weights and unit cost estimates for DRG-grouped SHC visits were obtained from the national price list for unit costs of healthcare services in Finland.[27]

The primary care contact type-related unit costs in the national price list include visit, phone call, home care visit and e-message costs for each type of healthcare professional (physicians, nurses, physiotherapists). In this study, we used the unit costs for visits/appointments for physicians and nurses. PA counselling was provided by special PA educators and visits to them were taken into account in the costs of the intervention. The costs of visits to the PA educator were estimated using the unit cost of physiotherapists.

Statistical methods

The number of appointments was presented as an absolute number and number per person years. Generalised Poisson regression was used to assess the effect of intervention in the number of appointments. For each patient time, from October 2016 to the start of the intervention, and 3 months after the start of the intervention, until the end of the follow-up, December 2019, together with a group (intervention or control) and their interaction, were used as explanatory factors in the model. Intervention participants were also matched with their controls. Subanalyses were done by healthcare area (primary vs specialised), personnel (physicians, nurses and physiotherapists), disease group (T2D and MSD), sex, age group, change in BMI and HbA1c. Because of very few physiotherapists' appointments sex, age group, BMI and HbA1c specific analyses were not carried out for them. Personal regression lines were used to define decrease (slope 0 or smaller) or increase (slope positive) in BMI or HbA1c values. Similarly, costs of the appointments were presented in euros per person-years. A mixed effect model was used to assess the effect of intervention in reducing the cost with the same explanatory factors as in Poisson regression. The R language and environment for statistical computing (V.4.0.3)[28] were used in statistical analyses. P values less than 0.05 were regarded as statistically significant.

Patient and public involvement

Patients and/or the public were not involved in the designing, conducting, reporting or making dissemination plans of this research.

RESULTS

Table 1 presents the absolute number of T2D and MSD appointments and number of T2D and MSD appointments per person-year in PHC and SHC before and after the start of the PA intervention in the intervention and control groups. In PHC, there were, among all patients in total, 1468 physician appointments related to TD2 and 2411 physician appointments due to MSD during the whole follow-up time. Physician appointments in the PHC related to T2D decreased, and among the patients in the control group, the number of appointments increased with a statistically significant difference in mean annual changes between groups (p=0.010). Also, in the PHC, the number of physician appointments related to MSD decreased in the intervention group and increased in the control group after the intervention with a statistically significant difference in change between groups (p<0.001). In the PHC, there were in total 6302 nurse appointments during the follow-up related to TD2 and only 210 related to MSD. In the intervention group, nurse appointments related to T2D declined and increased in the control group in the PHC after the intervention with a statistically significant difference between groups (p<0.001). The visits to the nurses related to MSD slightly increased in the intervention group and the difference in change compared with the control group was significant. There were only very few physiotherapist appointments in PHC before the intervention and the increase in the intervention group after the start of the intervention was due to visits to the PA counselling. A small increase was observed in SHC, but it was similar in intervention and control groups. In general, the number of visits to SHC was low except MSD physician visits.

Table 2 shows the costs of appointments per person-year, total costs of physician and nurse appointments in PHC and SHC before and after PA intervention in the intervention and control groups. In the intervention group, T2D-related physician and nurse costs of appointments per person-year in PHC decreased, and in the control group increased after the intervention with a statistically significant difference in change between groups (p<0.001). Also, the total costs of physician and nurse appointments per person-year in the intervention group decreased and increased in the control group after the intervention with a statistically significant difference in change between groups (p<0.001). The participants of

Table 1 Absolute number of T2D and MSD appointments (N) and number of T2D and MSD appointments per person-year (n/py) in PHC and SHC before and after PA intervention in intervention group (IG) and control group (CG)

Healthcare professional	Healthcare services	Disease group	N	IG, before n/py	IG, after n/py	CG, before n/py	CG, after n/py	P value for interaction*†
Physicians	PHC	T2D	1468	0.18	0.16	0.18	0.21	0.010
		MSD	2411	0.48	0.45	0.25	0.27	<0.001
	SHC	T2D	266	0.04	0.05	0.02	0.04	0.188
		MSD	1098	0.18	0.18	0.14	0.13	0.695
Nurses	PHC	T2D	6302	0.97	0.73	0.72	0.89	<0.001
		MSD	210	0.03	0.04	0.03	0.02	0.155
	SHC	T2D	100	0.01	0.02	0.01	0.02	0.407
		MSD	141	0.02	0.03	0.02	0.02	0.047
Physiotherapists	PHC	T2D	185	0.00	0.18*	0.00	0.00	0.977
		MSD	14	0.00	0.01	0.00	0.00	1.000
	SHC	T2D	9	0.00	0.00	0.00	0.00	0.992
		MSD	226	0.00	0.07	0.00	0.05	0.970

*Interaction of group and time
†Majority of these are PA counselling visits related to the intervention
MSD, musculoskeletal disorder; PA, physical activity; PHC, primary healthcare; SHC, specialised healthcare; T2D, type 2 diabetes.

the intervention group visited PA counselling on average three times during the intervention. One appointment lasted 60 min, and its cost was €85 per visit. Hence, the average cost of intervention appointments was €255 per person.

When analysing the number of PHC appointments separately for men and women, it was observed that the change between the intervention and control groups was significantly different in nurse appointments related to T2D in both sexes. The number of PHC nurse appointments related to T2D decreased in the intervention group and increased in the control group (online supplemental table 1).

When analysing the number of PHC appointments separately for sex and age group, it was observed that the change between the intervention and control groups was significantly different in nurse appointments related to T2D among women and men under 65 years of age as well as among older women. The number of visits by PHC nurses related to T2D decreased in the intervention group and increased in the control group in women and

Table 2 Costs of appointments per person-year (n/py) in PHC and SHC before and after PA intervention in intervention group (IG) and control group (CG)

Healthcare professional	Healthcare services	Disease group	N	IG, before, €/py	IG, after, €/py	CG, before, €/py	CG, after, €/py	P value for interaction*
Physicians	PHC	T2D	1468	17.85	12.60	16.90	17.77	<0.001
		MSD	2411	40.78	39.89	21.27	22.33	0.601
	SHC	T2D	266	10.63	12.55	5.94	12.22	0.013
		MSD	1098	46.90	47.48	36.72	33.49	0.756
	Both	Both	5243	116.16	112.51	80.83	85.81	<0.001
Nurses	PHC	T2D	6302	37.58	24.94	26.28	30.76	<0.001
		MSD	210	1.00	1.46	0.90	0.82	0.151
	SHC	T2D	100	1.23	2.91	1.50	3.40	0.982
		MSD	141	3.17	3.99	3.22	2.71	0.101
	Both	Both	6753	42.98	33.30	31.90	37.69	<0.001
Total costs of physicians and nurses				159.14	145.81	112.73	123.51	<0.001

*Interaction of group and time
MSD, musculoskeletal disorder; PA, physical activity; PHC, primary healthcare; SHC, specialised healthcare; T2D, type 2 diabetes.

Table 3 Absolute number of appointments (N) and number of T2D and MSD appointments per person-year (n/py) in PHC and SHC before and after the PA intervention in the intervention group (IG) and the control group (CG) by the change in HbA1c values

Healthcare professional	Healthcare services	Disease group	Change in HbA1c	N	IG, before n/py	IG, after n/py	CG, before n/py	CG, after n/py	P value for interaction*
Physicians	PHC	T2D	Increased	582	0.35	0.23	0.24	0.25	0.012
			Decreased	695	0.20	0.19	0.26	0.26	0.969
			Unknown	191	0.01	0.01	0.05	0.14	0.308
		MSD	Increased	853	0.51	0.52	0.26	0.36	0.275
			Decreased	1004	0.54	0.45	0.30	0.29	0.271
			Unknown	554	0.37	0.36	0.18	0.17	0.966
	SHC	T2D	Increased	99	0.04	0.11	0.02	0.04	0.486
			Decreased	117	0.07	0.03	0.03	0.04	0.015
			Unknown	50	<0.005	<0.005	0.01	0.04	0.999
		MSD	Increased	344	0.17	0.18	0.15	0.14	0.276
			Decreased	426	0.22	0.18	0.13	0.13	0.456
			Unknown	328	0.13	0.16	0.13	0.11	0.391
Nurses	PHC	T2D	Increased	2536	1.48	1.00	0.99	1.10	<0.001
			Decreased	2909	1.32	0.92	0.99	1.03	<0.001
			Unknown	858	0.08	0.10	0.21	0.58	0.002
		MSD	Increased	69	0.03	0.03	0.02	0.03	0.321
			Decreased	90	0.03	0.05	0.03	0.02	0.046
			Unknown	51	0.03	0.03	0.03	0.01	0.215
	SHC	T2D	Increased	42	<0.005	0.05	0.01	0.02	0.310
			Decreased	41	0.01	0.01	0.01	0.02	0.227
			Unknown	17	<0.005	<0.005	<0.005	0.01	1.000
		MSD	Increased	43	0.01	0.03	0.02	0.02	0.124
			Decreased	53	0.01	0.03	0.02	0.01	0.089
			Unknown	45	0.02	0.02	0.02	0.01	0.417

*Interaction of group and time
HbA1c, haemoglobin A1c; MSD, musculoskeletal disorder; PA, physical activity; PHC, primary healthcare; SHC, specialised healthcare; T2D, type 2 diabetes.

men under the age of 65 and in the older women (online supplemental table 2).

Among those whose HbA1c level increased, the number of physician appointments related to T2D in PHC decreased and the number of appointments increased in their matched controls after the intervention. The number of physician appointments related to T2D in SHC decreased in those participants in the intervention group whose HbA1c level declined, and the number of appointments increased in their matched controls after the intervention. Regarding the visits to nurses in PHC related to T2D, there was a decline in the intervention participants regardless of the change in the HbA1c level. The mean yearly change was statistically significantly different between the groups (p<0.001) (table 3).

Among the participants in the intervention group, the number of nurse visits related to T2D decreased in the PHC significantly more compared with their matched controls regardless of the change in BMI (table 4).

DISCUSSION

This study assessed the effect of PA counselling intervention on the number of contacts and costs of physicians' and nurses' appointments related to T2D and MSD per person-year in PHC and SHC before and after PA intervention in the intervention and control groups. To our knowledge, there is no earlier research on the effects of the PA counselling of patients with T2D on the use of other health services and related costs. The primary finding of this study is that among the participants in the intervention, the number of physician and nurse appointments in the PHC related to T2D decreased (physicians—11%, nurses—25%), while it increased in the control group (physicians +16.6%, nurses +24%) after the intervention.

The number of physician appointments related to MSD in PHC decreased in the intervention group. In the intervention group, T2D-related costs of physician and nurse appointments per person-year in PHC decreased (−8%) and increased in the control group (+10%)

Table 4 Absolute number of appointments (N) and number of T2D and MSD appointments per person-year (n/py) in PHC and SHC before and after PA intervention in the intervention group (IG) and control group (CG) by the change in BMI values

Healthcare professional	Healthcare services	Disease group	Change in BMI	N	IG, before n/py	IG, after n/py	CG, before n/py	CG, after n/py	P value for interaction*
Physicians	PHC	T2D	Increased	654	0.19	0.15	0.26	0.27	0.187
			Decreased	459	0.24	0.22	0.25	0.23	0.979
			Unknown	355	0.09	0.06	0.09	0.17	0.003
		MSD	Increased	987	0.43	0.45	0.28	0.32	0.640
			Decreased	794	0.62	0.49	0.31	0.35	0.054
			Unknown	630	0.37	0.39	0.19	0.20	0.899
	SHC	T2D	Increased	119	0.04	0.06	0.03	0.04	0.729
			Decreased	84	0.04	0.06	0.03	0.05	0.582
			Unknown	63	0.01	<0.005	0.01	0.04	0.985
		MSD	Increased	429	0.18	0.17	0.17	0.12	0.200
			Decreased	331	0.22	0.22	0.14	0.14	0.940
			Unknown	338	0.10	0.11	0.11	0.12	0.650
Nurses	PHC	T2D	Increased	2978	1.22	0.89	1.02	1.13	<0.001
			Decreased	1877	0.98	0.78	0.98	1.04	0.005
			Unknown	1448	0.37	0.24	0.35	0.65	<0.001
		MSD	Increased	89	0.03	0.04	0.03	0.03	0.238
			Decreased	67	0.04	0.05	0.03	0.03	0.558
			Unknown	54	0.02	0.02	0.02	0.02	0.648
	SHC	T2D	Increased	59	0.01	0.03	0.01	0.02	0.954
			Decreased	20	<0.005	0.01	0.01	0.02	0.989
			Unknown	21	<0.005	<0.005	<0.005	0.01	1.000
		MSD	Increased	58	0.01	0.02	0.03	0.02	0.267
			Decreased	44	0.02	0.05	0.02	0.01	0.019
			Unknown	39	0.01	0.01	0.01	0.02	0.716

*Interaction of group and time
BMI, body mass index; MSD, musculoskeletal disorder; PA, physical activity; PHC, primary healthcare; SHC, specialised healthcare; T2D, type 2 diabetes.

after the intervention. Also, total costs of physician and nurse appointments related to either T2D or MSD per person-year in PHC and SHC in the intervention group decreased and increased in the control group after the intervention.

Clinical studies have found that enhancement of the treatment to achieve glycaemic control, and in this way reducing or preventing complications, may be one of the most cost-effective interventions for patients with T2D with inadequate glycaemic control.[29] A study by Johansen *et al*[30] observed that lifestyle interventions can maintain glycaemic control to at least the same extent as medication. Hence, in addition to medication, the measures supporting healthy lifestyles should always be key components of the treatment of patients with T2D.[31] Our study found that, in addition to positive treatment effect on HbA1c levels that have been reported earlier,[22] participating in PA counselling also decreased the number of physician and nurse appointments related to T2D in the PHC.

Among patients with unsatisfactory glycaemic control, an association between visit frequency and better diabetes control has been shown in several studies.[32–34]The patients with T2D with poor glycaemic control showed significant and clinically meaningful improvements in HbA1c when contacted weekly by members of the healthcare system.[35] The international diabetes guidelines recommend regular and frequent visits, for example, every 3 months, and evaluation of the therapy until stable glycaemic control is achieved.[36 37] Every effort to improve the glycaemic control and well-being of patients with T2D is important in order to reduce diabetic complications.[38] Our study showed that a positive effect on achievement of treatment targets can also be achieved with PA counselling services,[22] simultaneously reducing the need of other contacts to health services.

Given the rising incidence of T2D, and thus the burden on healthcare services, health economic (HE) evaluations of the management of T2D are becoming increasingly relevant worldwide.[29]According to Liebl *et al*,[29]

HE studies have shown that in T2D hospital inpatient care, mostly due to diabetes complications, the costs are considerably high. Instead, diabetes medication-related and supplies-related costs are much lower.[29] In turn, Nuckols *et al*[39] reported in their review that multifaceted QI interventions that lower HbA1c appear to be a reasonably good value relative to usual care.[39]

Prior studies indicate that improvements in HbA1c can be associated with declines in healthcare utilisation and expenditures in the short term and long term.[40 41] Li *et al*[40] reported that the multicomponent interventions are more effective in risk factor control and early prevention of complications and, thus, more cost saving compared with standard glycaemic control for persons with T2D. Sidorov *et al*[41] reported that a specific disease management programme showed to be associated with a significant reduction in healthcare costs and other measures of healthcare use in patients with diabetes. Our study showed a cost reduction related to the decrease in other than intervention appointments. Our intervention itself led to, on average, a cost of €255 per person, which exceeds the 1-year cost reduction observed in costs of appointments related to T2D or MSD. However, the intervention cost is only realised during the intervention period, but the reduction in costs of other appointments can be cumulative during several years if improvements in lifestyles and treatment balance is achieved. So, it would be important to analyse the longer-term impact of the intervention. Also, in our study, only T2D-related and MSD-related visits were included in the analyses, as they are the most common causes of healthcare contacts among patients with T2D. Intervention might have also influenced the need of some other services, such as preventive, mental health, emergency and rehabilitation services.

Huckfeldt *et al*[42] estimated the association of effective lifestyle interventions for weight loss with long-term healthcare use and Medicare spending. This ancillary study used data from the Look AHEAD randomised clinical trial, which randomised participants with T2D to an intensive lifestyle intervention (ILI) or control group. They found that reductions in healthcare use and spending associated with an ILI for T2D decreased as participants aged. We also found that the effects on healthcare visits seemed to be bigger among elderly women but also among men under 65 years of age. They also stated that their ILI clinical trial was not associated with reduced total Medicare spending in the years immediately following the intervention.[42] However, from the same trial, Espeland *et al*[43] reported that ILI led to reductions in annual hospitalisations, hospital days and number of medications, resulting in cost savings for hospitalisation and medication across an average of 10 years.[43]

As healthcare costs associated with chronic illnesses are constantly increasing, it is imperative to identify interventions to reduce long-term spending without harming patient care.[42] Usually, the effect of interventions on healthcare costs are caused via improved treatment balance and thus reduce the need for appointments. In our study, we have been able to assess only the short-term effects of PA counselling provided in PHC settings on achieving treatment targets[22] and on health service use and costs. There is a need for longer-term analyses, taking also into account the possible decline in the onset of complications among patients attending lifestyle counselling.

In our study, the physician appointments in the PHC decreased most among those with increased HbA1c levels, but the number of nurse appointments related to T2D in PHC decreased irrespective to the change in HbA1c or BMI. The visits to the PA counsellor might have also provided the patients with other types of support that may have normally been handled by nurses.[42] However, aiming at better control is supported by the results by Wagner *et al*[24] who compared healthcare utilisation and costs over a 5-year period between two cohorts of diabetic patients: a group whose glycaemic control improved and a group in whom it did not improve. Their study suggested that a sustained reduction in HbA1c levels among adult diabetic patients is associated with significant cost savings within 1–2 years of improvement.

The start of exercise training may see numerous acute and chronic health issues arise in individuals with T2D, especially if they have been very inactive. Of primary concern are exercise-related hypoglycaemia and hyperglycaemia.[44] Increase in exercise might have also caused changes in other risk factors like blood pressure and thus caused a need for changes in medication and visits to the physician. In our study, we did not observe any remarkable increase in T2D-related SHC visits. Musculoskeletal injury is the most common exercise-related complication.[45 46] Unaccustomed exercise demands, especially during the initial weeks of a physical conditioning regimen, often result in muscle soreness, musculoskeletal injury and attrition.[47 48] In this study, a decrease was observed in MSD-related physician appointments in PHC and no change in SHC. It can be concluded that there was no increase in musculoskeletal injuries or other severe problems in the intervention group with the started exercise. Instead, the intervention participants benefited from the intervention in terms of their musculoskeletal health and had fewer physician appointments. A small increase in nurse appointments in SHC might be due to less severe acute symptoms related to the start of the exercise.

The study was conducted in a 'real-world' setting, and the results can be generalised to normal operation of healthcare. This can be considered as one of the strengths of this study. In the absence of a traditional study design, the study participation did not influence patient behaviour. All data needed for the study were collected from EHRs. The absence of the traditional study design and data extraction retrospectively from the existing EHRs resulted in the measurement data remaining partly incomplete. The measurement and laboratory data are based on the actual activities of the healthcare and thus

the data are missing for patients who did not visit in healthcare or regular laboratory check-ups. The information on appointments in the health services was also achieved from the EHRs, giving reliable and objective information on contacts. However, the number of physiotherapist visits is most likely underestimated as they less often record ICD-10 or ICPC-2 codes for the appointments compared with physicians and nurses for whom it is mandatory. In addition, the registry does not, however, include information from private service providers and thus might somewhat underestimate the number of visits. However, it is unlikely that the share of use of public and private services would have changed during the follow-up period of this study.

CONCLUSIONS

It can be concluded that PA counselling reduced the number of physicians' and nurses' appointments in SHC and PHC and thus the costs of treatment. This study shows that PA counselling provided with reasonably low cost in PHC offers significant benefits in the treatment of patients with T2D and improves the use of resources in healthcare.

Author affiliations
[1]Joint municipal authority for North Karelia social and health services (Siun sote), Joensuu, Finland
[2]Institute of Public Health and Clinical Nutrition, University of Eastern Finland, Joensuu, Finland
[3]Department of Health and Social Management, University of Eastern Finland - Kuopio Campus, Kuopio, Finland
[4]Institute of Healthcare Engineering, Management and Architecture, Aalto University, Helsinki, Finland
[5]Institute of Biomedicine/Sports and Exercise Medicine, University of Eastern Finland, Kuopio, Finland
[6]Department of Public Health and Social Welfare, Finnish Institute for Health and Welfare, Helsinki, Finland

Contributors TMM and TL planned the study design. TMM and TL were responsible for acquisition of data. M-LL compiled the data for analyses. M-LL and TMM carried out the statistical analyses. ML provided the cost data and estimates for the contacts in health services and expertise in related analyses and interpretation of results. TMM, TL, M-LL, ML, MV and HT participated in the interpretation of the data, and TMM drafted the manuscript. All authors contributed to the critical revision of the work and approved the final version of the manuscript. TMM is responsible for the overall content as guarantor.

Funding This study was partly funded by the Research Committee of the Kuopio University Hospital Catchment Area for the State Research Funding (project QCARE, Joensuu, Finland), the Strategic Research Council at the Academy of Finland (project IMPRO, 312703, 336325, 336329) and the Effective Life-style Counselling for Social and Health Care Cross-Functionally (VESOTE) project.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and the study was carried out totally as a register-based evaluation study, which, in accordance, with Finnish legislation (Act on secondary use of social and health data 26.4.2019/552; https://www.finlex.fi/fi/laki/ajantasa/2019/20190552), does not require ethics approval nor informed consent from the patients. Permission to use register data was achieved from the Joint Municipal Authority for North Karelia social and health services (Siun sote) (permission number: 930/13.00.01.01/2017).The study was carried out totally as a register-based evaluation study, which, in accordance, with Finnish legislation (Act on secondary use of social and health data 26.4.2019/552; https://www.finlex.fi/fi/laki/ajantasa/2019/20190552), does not require ethics approval nor informed consent from the patients. Data management and analyses have been carried out in accordance with relevant guidelines and regulations in Finland.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available. The health records data analysed in the current study are confidential and according to the Personal Data Act in Finland cannot be made publicly available to protect the privacy of the patients.

ORCID iD
Tuula Martiskainen http://orcid.org/0000-0002-5508-5545

REFERENCES

1 WHO. Global status report on noncommunicable diseases 2010, . 2011Available: https://apps.who.int/iris/bitstream/handle/10665/44579/9789240686458_eng.pdf?sequence=1&isAllowed=y [Accessed 8 Mar 2023].
2 Colberg SR, Sigal RJ, Fernhall B, *et al*. Exercise and type 2 diabetes: the American college of sports medicine and the American diabetes association: joint position statement. *Diabetes Care* 2010;33:2692–6.
3 Ogurtsova K, da Rocha Fernandes JD, Huang Y, *et al*. IDF diabetes atlas: global estimates for the prevalence of diabetes for 2015 and 2040. *Diabetes Res Clin Pract* 2017;128:40–50.
4 Lopez Stewart G, Tambascia M, Rosas Guzmán J, *et al*. Control of type 2 diabetes mellitus among general practitioners in private practice in nine countries of Latin America. *Rev Panam Salud Publica* 2007;22:12–20.
5 Franz MJ, MacLeod J. Success of nutrition-therapy interventions in persons with type 2 diabetes: challenges and future directions. *Diabetes Metab Syndr Obes* 2018;11:265–70.
6 Gregg EW, Chen H, Wagenknecht LE, *et al*. Association of an intensive lifestyle intervention with remission of type 2 diabetes. *JAMA* 2012;308:2489–96.
7 Colberg SR, Sigal RJ, Yardley JE, *et al*. Physical activity/exercise and diabetes: a position statement of the American diabetes Association. *Diabetes Care* 2016;39:2065–79.
8 Di Loreto C, Fanelli C, Lucidi P, *et al*. Validation of a counseling strategy to promote the adoption and the maintenance of physical activity by type 2 diabetic subjects. *Diabetes Care* 2003;26:404–8.
9 World Health Organization. *Action Plan for Implementation of the European Strategy for the Prevention and Control of Noncommunicable Diseases 2012–2016*. Geneva: WHO, 2012.
10 Rubio-Valera M, Pons-Vigués M, Martínez-Andrés M, *et al*. Barriers and Facilitators for the implementation of primary prevention and health promotion activities in primary care: a synthesis through meta-ethnography. *PLoS One* 2014;9:e89554.
11 World Health Organization. Primary health care, now more than ever. In: *The Worlds Health Report*. Geneva: WHO, 2008.
12 Garrett S, Elley CR, Rose SB, *et al*. Are physical activity interventions in primary care and the community cost-effective? A systematic review of the evidence. *Br J Gen Pract* 2011;61:e125–33.
13 Dawes D, Ashe M, Campbell K, *et al*. Preventing diabetes in primary care: a feasibility cluster randomized trial. *Can J Diabetes* 2015;39:111–6.
14 Dunbar JA, Hernan AL, Janus ED, *et al*. Challenges of diabetes prevention in the real world: results and lessons from the Melbourne diabetes prevention study. *BMJ Open Diabetes Res Care* 2015;3:e000131.

15 Sabale U, Bodegård J, Sundström J, *et al*. Healthcare utilization and costs following newly diagnosed Type-2 diabetes in Sweden: a follow-up of 38,956 patients in a clinical practice setting. *Prim Care Diabetes* 2015;9:330–7.
16 Wikström K, Lamidi M-L, Rautiainen P, *et al*. The effect of the integration of health services on health care usage among patients with type 2 diabetes in North Karelia, Finland. *BMC Health Serv Res* 2021;21:65.
17 Hodgson S, Morgan-Harrisskitt J, Hounkpatin H, *et al*. Primary care service utilisation and outcomes in type 2 diabetes: a longitudinal cohort analysis. *BMJ Open* 2022;12:e054654.
18 Kauppila T, Eriksson JG, Honkasalo M, *et al*. Relationship between number of contacts between previous dropouts with type 2 diabetes and health care professionals on glycaemic control: a cohort study in public primary health care. *Prim Care Diabetes* 2019;13:468–73.
19 Kaplan RM, Gold M, Duffy SQ, *et al*. Economic analysis in behavioral health: toward application of standardized methodologies. *Health Psychol* 2019;38:672–9.
20 Wilson DK, Lorig K, Klein WMP, *et al*. Efficacy and cost-effectiveness of behavioral interventions in nonclinical settings for improving health outcomes. *Health Psychol* 2019;38:689–700.
21 Roux L, Pratt M, Tengs TO, *et al*. Cost effectiveness of community-based physical activity interventions. *Am J Prev Med* 2008;35:578–88.
22 Martiskainen TM, Lamidi M-L, Venojärvi M, *et al*. Effectiveness of physical activity counselling provided for people with type 2 diabetes mellitus in primary healthcare in North Karelia, Finland: a register-based evaluation study. *BMJ Open* 2022;12:e058546.
23 Cawley J, Meyerhoefer C, Biener A, *et al*. Savings in medical expenditures associated with reductions in body mass index among US adults with obesity, by diabetes status. *Pharmacoeconomics* 2015;33:707–22.
24 Wagner EH, Sandhu N, Newton KM, *et al*. Effect of improved glycemic control on health care costs and utilization. *JAMA* 2001;285:182–9.
25 Porter ME. What is value in health care *N Engl J Med* 2010;363:2477–81.
26 Martiskainen T, Lamidi M-L, Venojärvi M, *et al*. Factors affecting the effectiveness of the physical activity counselling intervention implemented in primary health care in adults with type 2 diabetes. *BMC Endocr Disord* 2023;23:166.
27 Mäklin S, Kokko P, THL Helsinki. Working paper 21/2020; 2021. *Unit costs of health and social care in Finland in 2017*,
28 R Core Team. R. Vienna, Austria; R: A language and environment for statistical computing. R foundation for statistical computing, . 2020Available: https://www.R-project.org [Accessed 5 Aug 2022].
29 Liebl A, Khunti K, Orozco-Beltran D, *et al*. Health economic evaluation of type 2 diabetes mellitus: a clinical practice focused review. *Clin Med Insights Endocrinol Diabetes* 2015;8:13–9.
30 Johansen MY, MacDonald CS, Hansen KB, *et al*. Effect of an intensive lifestyle intervention on glycemic control in patients with type 2 diabetes: A RCT. *JAMA* 2017;318:637–46.
31 Sjöström M, Oja P, Hagströmer M, *et al*. Health-enhancing physical activity across European Union countries: the eurobarometer study. *J Public Health* 2006;14:291–300.
32 Rhee MK, Slocum W, Ziemer DC, *et al*. Patient adherence improves glycemic control. *Diabetes Educ* 2005;31:240–50.
33 Fenton JJ, Von Korff M, Lin EHB, *et al*. Quality of preventive care for diabetes: effects of visit frequency and competing demands. *Ann Fam Med* 2006;4:32–9.
34 Al OM. Diabetes care and control: the effect of frequent visits to diabetes care center. *Ann Saudi Med* 2014;34:229–34.
35 Piette JD, Weinberger M, Kraemer FB, *et al*. Impact of automated calls with nurse follow-up on diabetes treatment outcomes in a department of veterans affairs health care system: a randomized controlled trial. *Diabetes Care* 2001;24:202–8.
36 Inzucchi SE, Bergenstal RM, Buse JB, *et al*. Management of Hyperglycaemia in type 2 diabetes, 2015: a patient-centred approach. update to a position statement of the American diabetes association and the European association for the study of diabetes. *Diabetologia* 2015;58:429–42.
37 American diabetes association professional practice committee. Glycemic targets: standards of medical care in diabetes—2022. *Diabetes Care* 2022;45:S83–96.
38 Berecki-Gisolf J, Collie A, McClure RJ. Determinants of physical therapy use by compensated workers with musculoskeletal disorders. *J Occup Rehabil* 2013;23:63–73.
39 Nuckols TK, Keeler E, Anderson LJ, *et al*. Economic evaluation of quality improvement interventions designed to improve glycemic control in diabetes: a systematic review and weighted regression analysis. *Diabetes Care* 2018;41:985–93.
40 Li R, Zhang P, Barker LE, *et al*. Cost-effectiveness of interventions to prevent and control diabetes mellitus: a systematic review. *Diabetes Care* 2010;33:1872–94.
41 Sidorov J, Shull R, Tomcavage J, *et al*. Does diabetes disease management save money and improve outcomes? A report of simultaneous short-term Savings and quality improvement associated with a health maintenance organization-sponsored disease management program among patients fulfilling health employer data and information set criteria. *Diabetes Care* 2002;25:684–9.
42 Huckfeldt PJ, Frenier C, Pajewski NM, *et al*. Associations of intensive lifestyle intervention in type 2 diabetes with health care use, spending, and disability: an ancillary study of the look AHEAD study. *JAMA Netw Open* 2020;3:e2025488.
43 Espeland MA, Glick HA, Bertoni A, *et al*. Impact of an intensive lifestyle intervention on use and cost of medical services among overweight and obese adults with type 2 diabetes: the action for health in diabetes. *Diabetes Care* 2014;37:2548–56.
44 Kanaley JA, Colberg SR, Corcoran MH, *et al*. Exercise/physical activity in individuals with type 2 diabetes: a consensus statement from the American college of sports medicine. *Med Sci Sports Exerc* 2022;54:353–68.
45 Hootman JM, Macera CA, Ainsworth BE, *et al*. Association among physical activity level, cardiorespiratory fitness, and risk of musculoskeletal injury. *Am J Epidemiol* 2001;154:251–8.
46 Hootman JM, Macera CA, Ainsworth BE, *et al*. Epidemiology of musculoskeletal injuries among sedentary and physically active adults. *Med Sci Sports Exerc* 2002;34:838–44.
47 Pollock ML, Gaesser GA, Butcher JD, *et al*. Position stand: the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Medicine & Science in Sports & Exercise* 1998;30:975–91.
48 Cheung K, Hume P, Maxwell L. Delayed onset muscle soreness: treatment strategies and performance factors. *Sports Med* 2003;33:145–64.