



COST EFFECTIVENESS OF EXERCISE INTERVENTION AND LIFESTYLE COUNSELLING IN PREVENTION AND CONTROL OF DIABETES MELLITUS-A REVIEW

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ABSTRACT

Demographic transition, combined with urbanization and industrialization, has drastically changed global lifestyles. Consequently, lifestyle-related diseases like diabetes have emerged as major public health problems in all over the world. The increasing prevalence of diabetes mellitus has led to an unprecedented epidemic of death and disability worldwide. Despite this, little is known about what constitutes cost effective (CE) exercise intervention and lifestyle counselling to prevent and control diabetes within the global population. The objective of this paper was to assess the cost-effectiveness literature of exercise intervention and lifestyle counselling to prevent and control diabetes mellitus and improve the health status of the people. A systematic review has been done based on the published literature on cost effectiveness of exercise interventions to prevent and control diabetes mellitus. PubMed, Google Scholar, Scopus and Science Direct were searched in regards to identify cost-effectiveness evaluation of exercise intervention and lifestyle counselling for preventing and controlling diabetes mellitus among populations around the world. In this review 5 studies reporting on exercise intervention and lifestyle counselling were included. Most of the studies were from the developed countries. 10 of the 12 exercises and lifestyle counselling interventions included in the analysis were found to be cost-effective by the respective studies. In the case of gestational diabetes it has been seen from the studies that any kind of exercise intervention and lifestyle counselling did not contribute towards cost effectiveness. Apart from that, every form of physical exercises was shown to be consistently cost-effective in the included studies. It has been observed in this review that only a small number of studies examined the cost-effectiveness of exercise intervention and lifestyle counselling to prevent and control diabetes in the world. Given the opportunities and benefits, it is an area where the health economics and public health fields can play an important role in improving the health of millions of people, fighting with the non-communicable metabolic disorder, named diabetes.

KEYWORDS: Diabetes Mellitus, Exercise, Intervention, Lifestyle Counselling.



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1. INTRODUCTION

In advent of demographic transition prevalence of diabetes around the world has already been recognized as a critical concern. As International Diabetes Federation (IDF) clarified in 2014, approximately 387 million individuals have diabetes till date, which by the end of 2035 may rise up to 592 million. According to the IDF 2014 estimates, prevalence of diabetes in the world has reached up to 8.33 %.IDF has also stated that 77% of people with diabetes live in low- and middle-income countries and 179 million people with diabetes are undiagnosed. In addition to that more than 79,000 children developed type 1 diabetes and 21 million live births were affected by diabetes during pregnancy in 2013. More distressingly, diabetes caused 4.9 million deaths in 2014 and it has caused at least USD 612 billion dollars in health expenditure in 2014; which is equal to approximately 11% of total spending on adults all over the world.¹ Over the couple of decades economic evaluation of health system and health care programs has become a vital part of applied economics due to its crucial impact on the policy making processes in the countries. Generally, the additional benefits of an intervention are worthy as compared to another intervention or normal care which is generally being analyzed by economic evaluation.²⁻³ Economic evidence becomes essential for policy makers when they need to make resource allocation decisions for health care management and programs as well as for individuals to manage their resources efficiently for health care. Hence, a substantial evidence base on the cost-effectiveness of interventions is required to formulate effective and efficient decisions to cope up with the challenges of health care management.

Objective

The objective of this review is to pull together all existing evaluations that estimate the cost-effectiveness of exercise intervention and lifestyle counselling to prevent and/or control the occurrence of diabetes mellitus among the people who have been diagnosed with diabetes (type I, II and gestational diabetes). This review

allows for an assessment of the types of exercise interventions to identify the most effective as well as the least expensive intervention protocols followed. Such analyses consist of compiling incremental cost-effectiveness ratios (ICERs)³⁻⁴, which are calculated as a ratio of the difference in costs to the difference in effectiveness between the interventions being evaluated and the comparison intervention. Therefore, these ICERs can make it easier to decide how to allocate resources. Although numerous studies have emphasized on cost-effectiveness (CE) analyses of exercise interventions on diabetic patients, outcomes however remained inconclusive^{10,16,18,19,23}. Previous studies^{10,18,23} have been observed to emphasize on reduction in total healthcare cost introducing exercise and life-style counselling interventions, while contrarily loss of productivity and increased healthcare cost in similar population have also been reported^{16,19}. Further to that, one of the studies also has reported to confirm ineffectiveness of exercise as well as life-style counselling interventions¹⁶. With such a background a systematic review, which evaluates individual studies and summarizes results, would aid policy makers and healthcare researchers in prioritizing interventions to prevent or treat diabetes and its complications. The systematic review presented here, roughly following the Cochrane Reviewers' Handbook 4.2.2¹⁷ and includes all English language studies available from 2005 to May 2015.

2. Methods

A systematic review of the literature was conducted to find articles that provide evaluation of cost effectiveness of exercise intervention and lifestyle counselling aiming at the population having diabetes.

2.1 Search strategy

A search was conducted in the databases available in PubMed, Google Scholar, Scopus and Science Direct, using variations of the search string contained in Table 1. Reference lists of included studies were also searched for further applicable studies.

Table 1
Search Strategy

Databases	Search Items
PubMed, Google Scholar, Scopus and Science Direct	The following terms as words within the title, abstracts or texts of papers: (1) Disease of diabetes, such as "health", "diabetes", "type 1 diabetes," "type 2 diabetes," "impaired glucose tolerance," and "metabolic distress". (2) "cost-effectiveness" or "economic evaluation" or "cost benefit" as words within the title, abstracts or texts of papers

2.2 Selection Criteria

The selection criteria for this review specified four characteristics for studies. First, the studies had to analyze cost effectiveness of exercise intervention and lifestyle counselling, which were aimed at highlighting the most effective intervention incorporated at the least expense. Second, included papers had to mention interventions directed toward patients with type 1, type 2, or gestational diabetes mellitus (GDM). Third, the studies needed to measure outcomes life years gained (LYGs) or quality-adjusted life years gained (QALYs). Finally, the papers were in the English language published in between 2005 to 2015.

2.3 Data Extraction

At first studies were screened for compatibility with the aforementioned selection criteria by their key words, titles and abstracts. After that full texts of the studies were reviewed at length. A standard review form was used to extract data from those studies, which included country of origin, methodology including type of evaluation, comparators used, outcome measures, settings and participants and results. The primary outcome measure was reported as a measure of cost-effectiveness.

2.4 Country of Origin

Studies were conducted in the USA (1), the Netherlands (1), Canada (1), Finland (1) and India (1)^{10, 16, 18, 19, 23}.

2.5 Outcome Measures

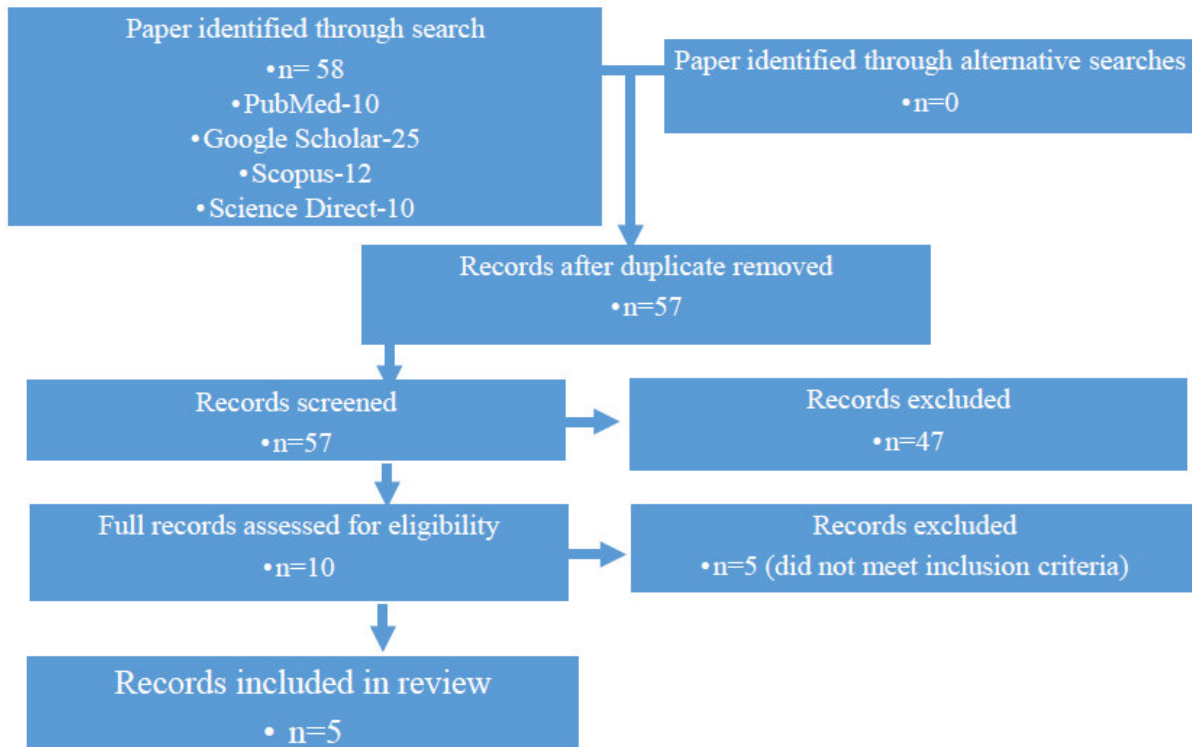
The primary outcome measure reported in all the studies were costs. Two studies reported

costs per quality adjusted life years gained. During pregnancy, total health care costs and costs of productivity losses were reported in two of the studies^{16, 19}. Each of the included research documents were evident to arrive at some judgment as to the cost effectiveness or cost-impact of the interventions being studied. Experimental outcomes were also observed to highlight on the effectiveness of the intervention measured by the number needed to treat (NNT) to prevent or delay one incident case of diabetes during the study and the incremental effectiveness of an intervention, which was equal to the NNT of that intervention²³. Among the 12 interventions, 2 interventions directed to prevent gestational diabetes were deemed to be strictly cost ineffective. Table 3 depicts included interventions by cost-effectiveness.

2.6 Comparators Used

In determining cost effectiveness of a specific intervention, the choice of comparator against which the cost effectiveness of the intervention is assessed plays a vital role. In this regard, studies included could be categorized in two sections. In section one, four of the studies were included, which assessed the cost-effectiveness of their intervention against "usual care or standard health care" cases where they compared to a situation where usual/standard care was given to the subjects by the general physicians. The remaining study compared the cost effectiveness of an intervention to an alternative intervention scenario where participants would be forced to obtain the intervention through alternative procedure.

Figure 1
PRISMA Flowchart



2. RESULTS AND DISCUSSION

The search yielded 58 abstracts (see Figure 1). After removing the duplicates, 57 abstracts were reviewed. Among the 57 studies, abstracts for 10 studies met the data extraction requirements and had sufficient information to include for this review. As a result the rest of

the studies were excluded from the review process. Then 10 records were thoroughly assessed based on the eligibility criteria and out of that, 5 studies were selected and included in the review. Table 2 summarizes the characteristics of the studies included in this review.

Table 2
List of Intervention Studies

Intervention Studies							
Study	Country	Setting	Intervention	Population	Comparator	Type of economic evaluation	Finding
The Diabetes Prevention Program Research Group (Herman, et al.2012)	USA	The Diabetes Prevention Program and its Outcomes Study (DPPPOS) clinical centres	- Lifestyle Intervention i) Diet and physical activity of moderate intensity, such as brisk walking. ii) A16-session core curriculum and subsequent individual sessions and group sessions with case managers were designed to reinforce the behavioural changes. -iii) Standard lifestyle recommendations were provided to all groups through written information and an annual 20- to 30-min individual session that emphasized the importance of a healthy lifestyle. -The medication interventions (metformin and placebo)	The DPP enrolled 3,234 participants with impaired glucose tolerance (IGT) and fasting hyperglycemia who were at least 25 years of age and had BMI of 24 kg/m ² or higher (22 kg/m ² in Asian-Americans). Mean age was 51 years of age and mean BMI was 34.0 kg/m ² . 68% were women, and 45% percent were members of minority groups	Compared to usual care	Cost effectiveness	Cost Effective- The cumulative quality-adjusted life years(QALYs) accrued over 10 years were greater for lifestyle (6.89) than metformin (6.79) or placebo (6.74). When costs and outcomes were discounted at 3% and adjusted for survival, lifestyle cost \$12,878 per QALY, and metformin had slightly lower costs and nearly the same QALYs as placebo. Over 10 years, from a payer perspective, lifestyle was cost-effective and metformin was marginally cost-saving compared with placebo.
Oostdamet al. (2012)	The Netherlands	Five hospitals and 20 midwifery practices in the Netherlands	-Aerobic and Strengthening exercises.	Participants were pregnant women at increased risk for gestational diabetes mellitus (GDM)	Compared to standard care	Cost effectiveness	No difference: No statistically significant differences - During pregnancy, total health care costs and costs of productivity losses were statistically non-significant (mean difference €1308; 95%CI €-229 -€3204).The cost-effectiveness analyses showed that the exercise program was not cost-effective in comparison to the control group for blood glucose levels, insulin sensitivity, infant birth weight or QALYs.
Coyleet al. (2012)	Canada	8 community based facilities	-Supervised Aerobic exercise -A maintenance program.	251 subjects aged 39 to 70 with a diagnosis of type 2 diabetes	Compared to no supervised exercise program	Cost effectiveness	Cost Effective- The incremental cost per QALY gained for the combined exercise program was \$4,792 compared with aerobic alone, \$8,570 compared with resistance alone, and \$37,872 compared with no program. The combined exercise program remained cost-effective for all scenarios considered within

Kolu et. al (2013)	Finland	Primary health-care maternity clinics	<p>-Various forms of physical activity, under the instruction of a physiotherapist.</p> <p>-Dietary counselling.</p>	Women (n = 399) with at least one risk factor for gestational diabetes mellitus (GDM) were included	Compared to Usual care	Cost effectiveness	<p>sensitivity analysis.</p> <p>Cost Ineffective - The ICER for birth-weight was almost 7 Euros, with 86.7% of bootstrap pairs located in the north-east quadrant, indicating that the intervention was more effective and more expensive in birth weight terms than the usual care was. The data show an 86.7% probability that each gram of birth weight avoided requires an additional cost of 7 Euros. Intervention was effective for birth weight but was not cost-effective.</p>
Ramachandran et al.(2007)	India	Asian Indian community	<p>-Lifestyle modification (LSM)</p> <p>i) Modification of diet and physical activity.</p> <p>ii) Some form of physical exercise as a daily routine.</p> <p>iii)Regular brisk walking</p> <p>-For the participants receiving metformin, the dose was 250 mg twice a day.</p>	35–55 years and of both sexes with reproducible impaired glucose tolerance.	Compared to standard health care advice	Cost effectiveness	<p>Cost Effective - The number of individuals needed to treat to prevent a case of diabetes was 6.4 with Lifestyle modification (LSM), 6.9 with metformin, and 6.5 with LSM and metformin. Cost-effectiveness to prevent one case of diabetes with LSM was INR 47,341(\$1,052), with metformin INR 49,280 (\$1,095), and with LSM and metformin INR 61,133 (\$1,359). Both lifestyle modification (LSM) and metformin were cost-effective interventions.</p> <p>The incremental effectiveness of an intervention was equal to the Number needed to treat (NNT) of that intervention. NNT is calculated as 1 divided by the absolute risk reduction, i.e., the difference in risk between the experimental and control groups in a clinical trial.</p>

This systematic review has revealed that the cost-effectiveness of exercise interventions and lifestyle counselling to prevent and control diabetes mellitus, has not yet been studied extensively. This has widened up scopes for generating and introducing cost saving interventions through exercises and lifestyle counselling, since the lack of such evidence in global health economics literature limits our ability to assess the cost effectiveness of interventions, which would reduce the burden of cost of diabetes on health systems and societies. However, the evidences that do exist in the literature provide some understandings into the potential cost effectiveness of different

types of exercise interventions and lifestyle counselling to reduce and prevent the cost of diabetes. There is a prospect for further research focusing onto economic evaluation of life-style modification with particular reference to exercise intervention in this field of study, following rigorous methodology to ensure that health economic paradigms have enough literature to address the cost implications of diabetes to society. In addition to that it is also important to provide evidence of benefits of analyses of cost-effectiveness of differential types of exercise interventions on improvement in the metabolic status of the people.

Table 3
Included interventions by cost-effectiveness

<i>Cost Effective Interventions</i>
Diet and physical activity of moderate intensity, such as brisk-walking.
The medication interventions (metformin and placebo)
Standard lifestyle recommendations were provided to all groups through written information
Supervised Aerobic exercise
A maintenance program
Modification of diet and physical activity.
Regular brisk walking
Some form of physical exercise as a daily routine.

A total of five studies met the inclusion criteria for this review. Given the broad scope of the research question and search strategy, this depicts a very limited evidence-base from which to draw insights on the potential cost-effectiveness of exercise intervention and lifestyle counselling to prevent and control diabetes among people. This finding implies that a lot more investment needs to be undertaken to understand the economics of effects of exercise intervention and lifestyle counselling for the betterment of diabetic society. One of the main reasons that can be offered here as a potential factor explaining the lack of research in the field is, a general lack of cost effectiveness studies in this field of exercise interventions, with the majority of research carried out in the field being only comparisons between exercises and only health benefits of different exercise interventions rather than incorporating cost aspect of the interventions. Another potential factor is that it is comparatively a new area of

research in terms of health economics. As a result still there is not enough work done to focus on the cost effectiveness of exercise interventions to improve the health status of the diabetic population. A number of conclusions can be drawn from the studies, though there was very limited amount of exercise and lifestyle counselling intervention studies have been taken into account based on the inclusion criteria. First, this review highlights the cost effectiveness of exercise interventions to prevent and control Type I, Type II and gestational diabetes. Of the 12 interventions examined by the included studies, 10 were seen as cost effective for the relevant population. The evidence-base drawn together by this review provides insights into particular interventions. In the case of gestational diabetes it has been seen from the studies that none of the exercise interventions and lifestyle counselling had beneficial impacts onto the issue of cost effectiveness. Contrary to that, exercise interventions irrespective of their form

were shown to be consistently cost-effective for other types of diabetes discussed in these studies. Apart from that, the exercise interventions compared, were evidentially against either sedentary lifestyle or irregular pattern of exercise routine. Furthermore, supervised aerobic exercise according to the need of individuals was also deemed to be cost effective for the diabetic population. Future economic evaluation of diabetes interventions should also consider to evaluate the cost effectiveness of multiple interventions that are in real-world settings. In most real-world settings, patients receive multiple interventions simultaneously. Majority of the studies were observed to evaluate the cost effectiveness of a single intervention only. While the strength of the review lies in the broad search strategy and research topic, the limited

Limitations of this Review and included studies

Number of included studies limits the inference that could be drawn from the identified literature. The studies were of varied scope and included different notions of what constituted a cost-effective intervention. There are inherent difficulties in comparing the outcome of the studies when the notion of what constituted a cost-effective intervention varied broadly between them.

3. CONCLUSION

Even though there is a global commitment to prevent and control diabetes, relatively little effort has been devoted to find out the cost effective ways to tackle and handle this non-communicable metabolic disorder among the world population. However, in light of the limited available evidence, this review suggests that interventions through exercises and lifestyle counselling to improve the health status of diabetic population can be cost effective. Further economic research has the potential to provide much needed guidance to policy-makers, healthcare service providers, families of the patients and patients themselves on dealing with diabetic issue more efficiently and enhancing the overall health status of the people.

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CONFLICT OF INTEREST

Conflict of interest declared none.

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