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Achievable Cost Saving and Cost-Effective Thresholds for Diabetes Prevention Lifestyle Interventions in People Aged 65 Years and Older: A Single-Payer Perspective

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ABSTRACT

Background More than 75% of people older than 65 years of age in the United States have prediabetes or diabetes. Diabetes is a burden on Medicare, the US health care payer. Intensive lifestyle interventions have successfully prevented diabetes cases, and medical nutrition therapy has also significantly reduced diabetes risk factors. Including medical nutrition therapy coverage for prediabetes is a policy decision to be made by Medicare, and cost-effectiveness data must support that decision.

Objective The aims of this study were to determine the thresholds of diabetes cases that need to be averted by prediabetes lifestyle interventions in order to be cost saving and/or cost-effective to a single health care insurance payer, such as Medicare; and to compare those thresholds with published intervention data to determine the feasibility of cost savings and/or cost-effectiveness.

Design This analysis used standard methods of cost-effectiveness and cost saving analysis. A health system perspective was used. Cost estimates for diabetes treatment and lifestyle interventions were based on published data. Costs for 3-, 6-, and 10-year lifestyle interventions were calculated. Sensitivity analyses were performed using least and most-conservative published data for health care and intervention costs.

Results The number of cases averted needed for base-case cost savings ranged from 882,883 to 2,443,686, and in sensitivity analysis from 394,148 to 6,738,678. Cost savings are likely in the base and least-conservative scenarios. The number of cases averted needed for base-case cost-effectiveness ranged from 454,755 to 1,258,692, and in sensitivity analysis from 212,225 to 4,843,262. Cost-effectiveness is likely in all interventions, except the 10-year interventions in the most-conservative scenario.

Conclusions Prediabetes lifestyle interventions for people aged 65 years or older are highly cost-effective and possibly cost saving to a health care insurance payer such as Medicare. It is likely that medical nutrition therapy could be even more cost saving and/or cost-effective than intensive lifestyle interventions. These results suggest that Medicare would receive financial benefit from providing coverage for these services.
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IN THE UNITED STATES, IT IS A GRAVE FACT THAT >75% of people aged 65 years and older have diabetes or prediabetes.[1,2] This is a tremendous burden to Medicare, the insurance payer for this population. The majority of Medicare spending goes to diabetes and other chronic diseases.[3-5] People with diabetes have a higher risk of death, cardiovascular disease, disability days, blindness, kidney failure, amputation, and neuropathy.[1,6] The Centers for Disease Control and Prevention estimate that diabetes costs the United States $174 billion per year in direct medical costs and economic losses.[1]

Several randomized controlled trials have demonstrated the ability of intensive lifestyle interventions for people with prediabetes to prevent progression from prediabetes to diabetes. Intensive lifestyle interventions include individual nutrition and physiology counseling, supervised exercise sessions, group sessions, individual follow-up, and more. The National Diabetes Prevention Program (DPP) was a 3-year intervention plus 3 years of follow-up activities. After 3.2 years, the DPP showed a 71% decrease in the incidence of diabetes in lifestyle intervention participants aged 60 years or older compared with the control group.[7-9] The 10-year follow-up study showed that the diabetes incidence rate in lifestyle intervention participants aged 60 years and older was 49% lower than the control group.[7] The Finnish Diabetes Prevention Study was also a 3-year intervention and showed a 58% lower incidence of diabetes in the lifestyle intervention group than the control group (all ages).[10,11] A 7-year follow-up study revealed a 43% reduction in relative risk for diabetes in the lifestyle intervention group compared with the control group.[12] The China Da Qing Diabetes Prevention Study was a 6-year intervention that showed a 42% decrease in the incidence of diabetes in those in the lifestyle intervention groups compared with the control group (all ages).[13] A 20-year follow-up study showed the intervention groups had 43% lower diabetes incidence than the control group.[14] Other studies have also shown that diabetes can be prevented through lifestyle interventions.[15-17]

These intensive lifestyle interventions have been modified and implemented in a variety of ways. Medical nutrition therapy (MNT) is one form of lifestyle intervention that includes individual diet and exercise counseling and is administered by registered dietitians or other nutrition professionals.[18,19] MNT has been shown to reduce diabetes risk factors, including weight and blood glucose levels, and has shown success in diabetes management.[15,19-21] A Cochrane review on the effectiveness of dietary advice alone for the prevention of diabetes pointed to the China Da Qing Diabetes Prevention Study,[16] which showed a decrease in the incidence of diabetes in the diet-only study group.[13] Because MNT is individualized and has fewer components, the intervention is tailored efficiently to each person and is less costly than intensive lifestyle interventions. In community settings, modified lifestyle interventions have been implemented globally. They have shown improved diabetes risk factors, including weight loss.[22-24] These programs are also less costly than intensive lifestyle interventions.[22]

Medicare currently provides MNT coverage for people with diabetes. Medicare does not, however, cover MNT to prevent diabetes, although MNT has been shown to improve diabetes risk factors and could financially benefit Medicare.[15,19-21] Including MNT coverage for prediabetes is a policy decision to be made by Medicare, and cost-effectiveness data must support that decision.[25] Short time-horizon studies have shown prediabetes lifestyle interventions to be cost-effective and even cost saving.[26-29] Long time-horizon studies based on 10- to 20-year predictive models have used different models with different data, and have come to different conclusions about the cost-effectiveness of prediabetes lifestyle interventions.[30,31] Predictive models are useful, but they also have limitations; it is difficult to base a long time-horizon policy decision on predictive models when long-term randomized controlled trial data are not available to support the conclusions of those models.

The policy decision to cover MNT for prediabetes can still be made based on cost-effectiveness data. The aims of this study were to determine the thresholds of diabetes cases that need to be averted by prediabetes lifestyle interventions in people aged 65 years and older in order to be cost saving and/or cost-effective to a single health care insurance payer, such as Medicare; and to compare those thresholds with published intervention data to determine the feasibility of cost savings and/or cost-effectiveness to Medicare.

METHODS

This study used standard methods of cost analysis. Cost savings calculations are used to determine how many cases of diabetes would need to be prevented to save money for a health care insurance payer. Alternatively, cost-effectiveness calculations are used to determine how many cases of diabetes would need to be prevented for the treatment to be considered a prudent use of money. The analysis was performed to inform the decision of whether lifestyle interventions for prediabetes should be covered by a single health insurance payer for people aged 65 years and older. Therefore, a health system perspective was used rather than a societal perspective. The values of parameters were taken from published sources and conservative judgments were made when judgments were necessary. Published estimates of average annual per capita diabetes costs were used. All costs were reported in 2007 dollars. This study is based on published data and is therefore exempt from Institutional Review Board approval, as stated by Federal Regulation 45 CFR § 46.101(b).[32]

Cost of Diabetes

Base-Case Estimate. This estimate was derived through an Archimedes model that used microcosted data from Kaiser-Permanente, a large nonprofit health management organization. Data estimated the annual per capita spending for a person with diabetes (all ages) to be $5,694.[30] This number was used as the base-case diabetes cost in this analysis because the model uses actual spending from a health management organization, and the model has been reliable in many biomedical modeling situations.[30] It should be noted that average health care costs in the United States increase with age and health status, and health care costs are highest for the elderly.[33] Therefore, the average cost of a person aged 65 years or older is likely to be higher than $5,694.

Least-Conservative Estimate. The American Diabetes Association estimated a yearly cost of $9,713 for a person with diabetes aged 65 years or older.[34] They used a regression-based approach to make estimates[34]; it has been suggested that this approach can result in an overestimation of costs because of the use of epidemiological data.[35] Therefore, this number was used as a least-conservative estimate for sensitivity analysis.

Most-Conservative Estimate. A more conservative approach known as "estimated attributable fractions" has been suggested as an alternative to regression-based estimates for determining annual diabetes health care expenditures.[35] One attributable fraction analysis used Medical Expenditure Panel Survey data to estimate an average annual per capita expenditure for people with diabetes aged 65 years or older to be $3,407.[35] This number is used as the most-conservative estimate for sensitivity analysis.

Length of Treatment Time with Diabetes

The average cost savings of averted diabetes cases depends on the length of time that one would have been treated for diabetes. The average duration of diabetes in those aged 65 years and older is estimated to be 9.9 years.[34,36] Therefore, a treatment time of 9.9 years is used as the base-case estimate. This is based on estimates of diabetes incidence in specific age groups and the average duration per age group.[34,36] The longest estimated diabetes treatment duration is 13 years if diagnosed at age 65 years, and the shortest time is estimated to be 6 years if diagnosed at age 80 years. Treatment of 13 years

Table 1. Differences in cumulative absolute incidence of diabetes between control and lifestyle intervention groups at specified years after the start of the intensive lifestyle intervention; and corresponding number of diabetes cases that hypothetically could have been averted out of the 2007 population (people aged 65 years or older with prediabetes)

	Difference in % (all ages)	Estimated no. of cases averted (age 65 years or older)	Study/model
Observed			
2-y follow-up	8	1,068,570	FDPS[a46]
3-y follow-up	14.5	1,936,784	DPP[b8]
4-y follow-up	12	1,602,855	FDPS[46]
6-y follow-up	21.7	2,898,497	CDQDPS[c13]
7-y follow-up	15	2,003,569	FDPS[46]
20-y follow-up	13	1,736,427	CDQDPS[14]
Modeled			
10-y follow-up	14.3	1,910,069	Archimedes[30]
20-y follow-up[d]	11.6	1,549,427	Archimedes[30]
20-y follow-up	20	2,671,426	Markov[31]

[a]FDPS=Finnish Diabetes Prevention Study.
[b]DPP=Diabetes Prevention Program.
[c]CDQDPS=China Da Qing Diabetes Prevention Study.
[d]The study providing these data also modeled 30-year follow-up results; because of the inability to compare 30-year results with other studies, only 10- and 20-year results were included here.

(diagnosis at age 65 years) is used as the least-conservative estimate, while treatment of 6 years (diagnosis at age 80 years) is used as a most-conservative estimate in sensitivity analyses.

Number of Diabetes Cases Prevented

The decreases in absolute risk of diabetes during intensive lifestyle intervention trials, as well as the Markov[31] and Archimedes[30] predictive models, are based on published data (Table 1). The estimated prevalence of prediabetes in the 2007 US population aged 65 years and older[1,34] was then multiplied by the percentage decrease. This provided an estimate of how many cases of diabetes could be prevented in a situation similar to that of the intervention. In order to determine the attainability of the cost saving thresholds, the number of cases needed to be averted was compared with the data from studies and models of interventions of similar length.

Cost of Lifestyle Intervention

Total gross cost of a lifestyle intervention for all people with prediabetes aged 65 years or older was based on the cost data from the DPP. The cost of MNT is less than an intensive lifestyle intervention, but MNT has not been studied to determine long-term reduction in diabetes incidence. The same is true for many successful community lifestyle interventions that have been implemented for much less than the cost of DPP.[22] For that reason, MNT and community lifestyle intervention costs were not used for this analysis. Other studies have also used DPP costs to estimate cost-effectiveness.[37] The DPP had the highest costs of any interventions that reported costs.[31,38] In the DPP, the per capita cost was $1,875 the first year, $910 the second year, and $941 the third year.[31,38] For this analysis, it was assumed that the annual per capita cost of an intervention longer than 3 years would have the same annual per capita cost as the third year. The length of the intervention determines the total cost of the program.

The original intensive DPP intervention was 3 years, with 3 years of follow-up,[8] the Finnish Diabetes Prevention Study was 3 years and the China Da Qing Diabetes Prevention Study was 6 years.[12,13] Therefore, 3-year and 6-year threshold analyses are made to enable comparisons with these research interventions. The average life expectancy of a person without diabetes at age 65 years is approximately 18.7 years,[39] but it is highly unlikely that a person would receive this many years of a lifestyle intervention. A 10-year intervention is used to show costs of long-term lifestyle intervention for prediabetes.

The gross costs of the program were estimated with the assumption that all people with prediabetes would participate in a lifestyle intervention for the duration of the intervention. It is unlikely, however, that this will occur because some of those people will develop diabetes and stop the lifestyle intervention. The DPP and Finnish Diabetes Prevention Study showed 3-year cumulative diabetes incidence rates in the intervention groups of 14.4% and 11%, respectively. The Finnish Diabetes Prevention Study and China Da Qing Diabetes Prevention Study showed 6-year cumulative diabetes incidence rates in the intervention groups of 23% and 46%, respectively. Using the incidence rates of 11% in the 3-year intervention and 23% in the 6-year intervention, the number of people with prediabetes was diabetes incidence-adjusted to reflect the number of people continuing with prediabetes. This number was used to calculate an adjusted number of people with prediabetes and an adjusted gross program cost.

Cost Savings Threshold

The cost saving model is meant to estimate the number of diabetes cases needed to be averted in order for the lifestyle intervention to be cost saving to the Medicare system. The first parameter in this model, C, is the estimated gross cost of the lifestyle intervention. The next parameter, T, is the estimated per capita treatment costs saved by preventing a case of diabetes. In this model, the gross costs of the program are divided by the per-capita treatment costs to give A, the number of diabetes cases that must be averted in order to be cost saving to Medicare.

$$A = C/T$$

Cost-Effectiveness Threshold

The cost-effectiveness model is meant to estimate the number of diabetes cases needed to be averted in order to make the lifestyle intervention cost-effective for the Medicare system. The parameters C and T are the same as in the cost saving model. The parameter Q is the number of quality-adjusted life years (QALYs) saved by the intervention. The number of QALYs saved is estimated to be 0.39 for those aged 65 years and older based on DPP data[40] and 0.29 based on the analysis of three nutrition interventions in an Australian context.[26] Because three studies were used to estimate 0.29 QALYs saved by lifestyle interventions, this number was chosen to be the base-case value. Two predictive models have estimated the QALYs saved by a lifestyle intervention (discounted at 3%) to be 0.16 at a 30-year follow-up[30] and 0.41 at a 20-year follow-up,[31] therefore, these numbers are used as the most-conservative and least-conservative estimates, respectively, for sensitivity analyses.

The parameter W is the amount society is willing to pay in order to save a QALY. In past years, $50,000 was used as a general number for society's willingness to pay for treatment to determine cost-effectiveness. This amount has not been changed nominally since 1982.[41] It is now suggested that by updating this number to the current dollar value and to social changes, society's willingness to pay has a lower bound of $183,000 per QALY and an upper bound of $264,000 per QALY.[41] For this analysis, $183,000 was used as the base-case analysis, while $50,000 was used as the most-conservative and $264,000 was used as the least-conservative cases, for sensitivity analyses.

In this model, the gross costs of a lifestyle intervention for all people with prediabetes aged 65 years or older is divided by the sum of per-capita diabetes costs to be saved, and the product of society's willingness to pay for a QALY and the estimated QALYs saved by a lifestyle intervention. This gives the estimated number of diabetes cases that must be averted in order for the intervention to be cost-effective to the Medicare system.

$$A = C/(T + WQ)$$

RESULTS

Cost Saving Thresholds

The results of the cost saving analysis are found in Table 2 and the summary of decreases in absolute risk of diabetes produced by trials and models is presented in Table 1. In the base-case scenario, during a 3-year lifestyle intervention, 882,883 cases of diabetes would need to be averted in order to make the intervention cost saving. Published data from the DPP showed that after 3 years of the intervention, a 14.5% decrease in diabetes incidence was observed.[8] Using Table 1, that would translate to approximately 1,936,784 cases averted in the 2007 population of people aged 65 years and older with prediabetes. This suggests that averting 882,883 cases is attainable and would be cost saving to a single payer. Also in the base-case scenario, in a 6-year intervention (adjusted intervention cost), approximately 1.4 million cases of diabetes would need to be prevented. Using Table 1, the observed results of the 6-year intervention follow-up, extrapolated to the 2007 population, estimates that nearly 2.9 million cases would be averted. This comparison suggests that the 6-year intervention would also be cost saving.

In sensitivity analysis, the least-conservative estimates show that lifestyle interventions are highly cost saving. The range of cases of diabetes needed to be averted to achieve cost savings ranges from 394,148 cases in a 3-year intervention to 1,090,941 cases in a 10-year intervention. Even the most conservative 20-year model shows an 11.6% decrease in incidence[30]—approximately 1,549,427 cases of diabetes averted in the 2007 population. This exceeds the threshold needed for cost savings. Sensitivity analysis for the most-conservative case shows possible cost savings in a 3-year intervention if the Markov model is used for comparison.[31] Observed and modeled data do not suggest that cost savings would be achieved in the other intervention lengths in the most-conservative case.

Comparison shows that all three different-length interventions are likely to be cost saving for both the base-case and least-conservative case. In the most-conservative case, only the 3-year intervention has the potential of being cost saving.

Cost-Effective Thresholds

The cost-effective threshold results are presented in Table 3 and the summary of decreases in absolute risk of diabetes produced by trials and models is presented in Table 1. In the base-case scenario using adjusted intervention costs, 454,755; 711,377; and 969,193 cases of diabetes would need to be averted to achieve cost-effectiveness in a 3-, 6-, and 10-year intervention, respectively. Using Table 1, results from Diabetes Prevention trials extrapolated to the 2007 population estimate that approximately 1,936,784 and 2,898,497cases would be averted in a 3-year and 6-year intervention. Using a predictive model for results at 10 years, an estimated 1,910,069 cases of diabetes would be prevented. Trial data and models suggest that roughly two to three times as many cases would be averted as would be needed to achieve cost-effectiveness.

Sensitivity analysis also shows cost-effectiveness. In the least-conservative case, 212,225 cases of diabetes would need to be prevented to achieve cost-effectiveness in a 3-year intervention, and up to 452,303 cases would need to be prevented to achieve cost-effectiveness in a 10-year intervention

Table 2. Input parameter values and threshold analysis for cost saving level of a prediabetes lifestyle intervention

Parameter label	Base-case value	Least-conservative value	Most-conservative value
3-y intervention			
C^a ($)	49,768,658,928[32,36]	49,768,658,928[32,36]	49,768,658,928[32,36]
T^b ($)	56,371[30,34]	126,269 (diagnosis at 65 years old)[30,34]	20,442 (diagnosis at 80 years old)[32,34]
6-y intervention			
C ($)	87,475,831,272[32,36]	87,475,831,272[32,36]	87,475,831,272[32,36]
C ($) (adj[c])	77,853,489,832	77,853,489,832	77,853,489,832
T ($)	56,371[30,34]	126,269 (diagnosis at 65 years old)[30,34]	20,442 (diagnosis at 80 years old)[32,34]
10-y intervention			
C ($)	137,752,061,064[32,36]	137,752,061,064[32,36]	137,752,061,064[32,36]
C ($) (adj[c])	106,069,087,019	106,069,087,019	106,069,087,019
T ($)	56,371[30,34]	126,269 (diagnosis at 65 years old)[30,34]	20,442 (diagnosis at 80 years old)[32,34]
Cases averted to achieve cost-savings	← *no. of cases* →		
A^d (3-y)	882,883	394,148	2,434,628
A (6-y)	1,551,799	692,774	4,279,221
A (6-y adj[c])	1,381,101	616,569	3,808,506
A (10-y)	2,443,686	1,090,941	6,738,678
A (10-y adj[c])	1,881,638	840,025	5,188,782

[a]C=gross cost of lifestyle intervention.
[b]T=total costs saved; the cost of a person developing diabetes.
[c]The adjustment is a more realistic cost of the lifestyle intervention because it takes diabetes incidence into account. It is based on diabetes incidence reported in the lifestyle intervention groups in the literature. The number of people who get diabetes is subtracted from the number of people receiving the prediabetes lifestyle intervention after year 3 and after year 6.
[d]A=number of diabetes cases needed to avert in order to make the lifestyle intervention cost saving.

(adjusted intervention cost). The most-conservative case shows that 1,749,830 cases in a 3-year intervention, 2,737,272 in a 6-year intervention (adjusted intervention cost), and 3,729,312 cases in a 10-year intervention (adjusted intervention cost) would need to be prevented. Prevention estimates based on study data presented in Table 1 suggest that lifestyle interventions can prevent the number of cases of diabetes needed to make all interventions cost-effective in the least-conservative case, and 3- and 6-year interventions (adjusted intervention cost) cost-effective in the most-conservative case.

DISCUSSION

These results show that insurance coverage for lifestyle interventions for prediabetes is cost-effective and achievably cost saving for Medicare.[42] These results are dependent, in part, on trial data as well as mathematical models. The cost-effectiveness results are robust to sensitivity analyses. These results are corroborated by many cost-analysis studies conducted globally that show the cost-effective and/or cost saving nature of lifestyle interventions for prediabetes.[29,43-47] These results also suggest that 3-year or 6-year interventions are the most likely to be cost saving as well as cost-effective.

In the United States, during a 3-year time-horizon, screening for prediabetes and providing lifestyle interventions was calculated to be cost-effective and cost saving to Medicare.[37] The long time-horizon models, Markov and Archimedes, are mathematical models used to simulate the cost-effectiveness of prediabetes interventions and the progression of prediabetes to diabetes. During a long time-horizon in the United States, Herman and colleagues used a 20-year Markov model to show the lifestyle intervention to be cost saving.[31] Eddy and colleagues, in contrast, used a 30-year Archimedes model (which also included 10- and 20-year modeling) to show the lifestyle intervention to be neither cost-effective nor cost saving.[30] The differences between these two analyses likely stem from use of different models and different data sources to estimate the per-capita annual diabetes treatment costs. The Markov model 20-year analysis and Archimedes model 30-year analysis were conducted before the long-term follow-up studies were published by the DPP and China Da Qing Diabetes Prevention Study. The 20-year follow-up to the China Da Qing Diabetes Prevention Study provides some data from the Chinese context with which to compare the long-term predictions of these models. The China Da Qing Diabetes Prevention Study found a 13% decrease in absolute risk of diabetes in the lifestyle intervention group.[14] The Archimedes model predicted an 11.6% decrease[30] and the Markov model predicted a 20% decrease.[31] More analysis is needed to statistically compare the two models. A 20-year follow-up study to the DPP is ex-

Table 3. Input parameter values and threshold analysis for cost-effectiveness of a prediabetes lifestyle intervention

Parameter label	Base-case value	Least-conservative value	Most-conservative value
3-y intervention			
C[a] ($)	49,768,658,928[32,36]	49,768,658,928[32,36]	49,768,658,928[32,36]
T[b] ($)	56,371[30,34]	126,269 (diagnosis at 65 years old)[30,34]	20,442 (diagnosis at 80 years old)[32,34]
Q[c]	0.29[30]	0.41[26,38]	0.16[30]
W[d]	183,000[39]	264,000[39]	50,000
6-y intervention			
C ($)	87,475,831,272[32,36]	87,475,831,272[32,36]	87,475,831,272[32,36]
C ($) (adj[e])	77,853,489,832	77,853,489,832	77,853,489,832
T ($)	56,371[30,34]	126,269 (diagnosis at 65 years old)[30,34]	20,442 (diagnosis at 80 years old)[32,34]
Q	0.29[30]	0.41[26,38]	0.16[30]
W	183,000[39]	264,000[39]	50,000
10-y intervention			
C ($)	137,752,061,064[32,36]	137,752,061,064[32,36]	137,752,061,064[32,36]
C ($) (adj[e])	106,069,087,019	106,069,087,019	106,069,087,019
T ($)	56,371[30,34]	126,269 (diagnosis at 65 years old)[30,34]	20,442 (diagnosis at 80 years old)[32,34]
Q	0.29[30]	0.41[26,38]	0.16[30]
W	183,000[39]	264,000[39]	50,000
Cases averted to achieve cost-effectiveness	← *no. of cases* →		
A[f] (3-y)	454,755	212,225	1,749,830
A (6-y)	799,300	373,017	3,075,587
A (6-y adj[e])	711,377	331,985	2,737,272
A (10-y)	1,258,692	587,406	4,843,262
A (10-y adj[e])	969,193	452,303	3,729,312

[a]C=gross cost of lifestyle intervention.
[b]T=total costs saved; the cost of a person developing diabetes.
[c]Q=quality-adjusted life years saved per case of diabetes averted.
[d]W=society's willingness to pay for disease treatment per quality-adjusted life year saved.
[e]The adjustment is a more realistic cost of the lifestyle intervention because it takes diabetes incidence into account. It is based on diabetes incidence reported in the lifestyle intervention groups in the literature. The number of people who get diabetes is subtracted from the number of people receiving the prediabetes lifestyle intervention after year 3 and after year 6.
[f]A=number of diabetes cases needed to avert in order to make the lifestyle intervention cost-effective.

pected around 2014[48] and can provide data from the US context with which to compare the long-term predictive models. Even considering differences, the Markov and Archimedes models and the China Da Qing Diabetes Prevention Study all give relatively similar numbers for the cases of diabetes averted by an intensive lifestyle intervention after 20 years.

The cost saving thresholds of many of the lifestyle intervention scenarios easily fall within the estimates provided by the models and data. The agreement of the estimates also provides confidence in the cost saving nature of the interventions. This threshold analysis was sensitive to diabetes treatment costs, as was true in other studies.[31] The thresholds were also sensitive to the length of the intervention. The 10-year intervention was cost saving in the least-conservative case and possibly cost saving in the base-case, while both the 3-year and 6-year interventions were cost saving in both the base and least-conservative case. The DPP demonstrated a 10-year decreased risk of diabetes incidence after a full intervention for 3 years and then a 3-year follow-up intervention,[8] and the Finnish Diabetes Prevention Study demonstrated a 7-year decreased risk of diabetes after only a 3-year intervention.[48] In addition, the China Da Qing Diabetes Prevention Study intervention was implemented for only 6 years, but a 13% decreased incidence of diabetes was shown at the 20-year follow-up.[14] One can conclude from the results that a 10-year intervention might not be necessary for the lifestyle intervention to be effective in decreasing the incidence of diabetes because previous studies have shown a sustained effect with 3-year and 6-year interventions. It is possible that longer-term interventions are more beneficial and could result in an even lower long-term incidence of diabetes, however, this has not been examined in the literature so far.[15]

With the conservative nature of this analysis, the cost savings and cost-effectiveness to Medicare could be underestimated. DPP costs were used, yet it is unlikely that Medicare would cover such costly intensive lifestyle interventions. Other interventions, such as MNT, are less resource intensive and tailor services to the individual to obtain optimal outcomes.[19,21] This analysis also does not take into account the return of people with prediabetes to a normal glucose state. A post-hoc exploratory study of the DPP suggested that the return to normal blood glucose levels might be higher in the intervention group[49]; this would bring even more benefit to the insurance payer.

This analysis has limitations. The prevalence of prediabetes in adults aged 65 years and older has not been published and was therefore estimated. Also, this analysis does not have diabetes costs specific to Medicare. As this analysis is sensitive to the cost of diabetes treatment, it would be beneficial to have actual expenditure data attributed to diabetes and diabetes-related treatments. This analysis also assumes that all people aged 65 years and older with prediabetes will participate in a lifestyle intervention, which affects the cost estimates for the intervention.

More research is needed in the area of MNT and community diabetes prevention programs to assess the effectiveness at decreasing diabetes incidence in the long term. Continued data from randomized controlled trials are also needed to more fully understanding the long-term effects of these interventions and compare interventions with predictive models. In addition, more information is needed about the effects of intensive lifestyle interventions on mortality and morbidity to better understand the influence on health care costs. Finally, no randomized controlled trials have explored the long-term effects of lifestyle interventions of different lengths, which would be helpful in determining the optimal intervention length.

CONCLUSIONS

Lifestyle interventions for people older than 65 years with prediabetes can prevent many cases of diabetes. Most lifestyle interventions are cost-effective to a single health care insurance payer. In addition, even with very costly interventions, it is possible that lifestyle interventions for this population would be cost saving. In addition to large intensive lifestyle interventions, MNT has also been shown to significantly reduce diabetes risk factors in participants. Therefore, it is likely that covering MNT would be even more cost saving and/or cost-effective. These results suggest that it would be fiscally responsible for Medicare or a similar health care insurance payer to provide coverage for MNT for individuals with prediabetes.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

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