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One-year changes in glucose and heart disease risk factors among participants in the WISEWOMAN programme

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Abstract

Background: WISEWOMAN provides chronic disease risk factor screening, referrals and lifestyle interventions to low-income, uninsured women, to reduce their heart disease and stroke risk. Participants learn behaviour-changing skills tailored to low-income populations, such as collaborative goal setting, the need to take small steps and other empowerment techniques.

Aim: To quantify the baseline prevalence of pre-diabetes (fasting blood glucose 5.5–6.9 mmol/l) and diabetes among WISEWOMAN participants and assess one-year changes in glucose levels and other diabetes risk factors.

Methods: We used 1998–2005 baseline and one-year follow-up data from WISEWOMAN participants. Using a multilevel regression model, we assessed one-year changes in glucose, blood pressure (BP), total cholesterol and 10-year risk of coronary heart disease (CHD) among participants with baseline pre-diabetes (n=688) or diabetes (n=338).

Results: At baseline, 15% of participants had pre-diabetes and 10% had diabetes. Of those with diabetes, 26% were unaware of their condition before baseline screening. During the one-year follow-up period, participants with pre-diabetes experienced statistically significant improvements in glucose (2.9%) and cholesterol (2.1%) levels and 10-year CHD risk (4.3%). Participants with newly diagnosed diabetes experienced statistically significant improvements in glucose (11.5%), BP (3.1%–3.5%) and cholesterol (6.4%) levels. Participants with previously diagnosed diabetes experienced significant improvements in BP (1.9–3.4%), cholesterol level (3.8%), and 10-year CHD risk (8.5%).

Conclusions: Implementing patient-centered, comprehensive and multilevel interventions and demonstrating their effectiveness will likely lead to the adoption of this approach on a much broader scale.

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Key Words

Diabetes, cardiovascular disease, prevention, women, medically uninsured, screening

Introduction

Over time, the prevalence of pre-diabetes (fasting blood glucose 5.5–6.9 mmol/l) and diabetes has increased in the United States (US).[1–3] People with diabetes have a higher risk of heart disease and stroke than people without diabetes,[4] and those with pre-diabetes have a higher risk of these diseases than those without the pre-condition.[4–7] Thus, intervention programmes are needed to prevent both pre-diabetes and diabetes and to control heart disease risk factors among people with these conditions.

The Well-Integrated Screening and Evaluation for Women Across the Nation (WISEWOMAN)[8,9] project is a US Centers for Disease Control and Prevention (CDC) funded, multi-component intervention programme aimed at reducing heart disease and stroke risk in low-income, underinsured, and uninsured women aged 40–64 years. WISEWOMAN provides preventive services including blood pressure (BP), cholesterol, and glucose screening; lifestyle interventions to help women develop a healthier diet, increase physical activity, and quit smoking; referrals for medical treatment for participants with abnormal values; and one-year follow-up visits to provide feedback to participants and their providers about changes in participants' risk factor profiles.[9] The goal of the programme is to improve participants' health by reducing risk, by offering heart disease and stroke-prevention activities in conjunction with the National Breast and Cervical Cancer Early Detection Program (NBCCEDP).

Patient-centered lifestyle programmes are especially important for low-income women because they typically receive inconsistent care. For example, roughly one in five (18%) working-age women in the US lacks health insurance,[10] and ethnic

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minority women – even when insured – are less likely than white women to have a consistent relationship with a healthcare provider.[11] Ensuring access to preventive health serv-ices requires expanding healthcare coverage, and fostering consistent and trusting relationships between providers and patients.[12] Thus, preventive healthcare strategies that are sensitive to the economic and cultural context of women's lives are needed.

With funding from Congress in 1995, CDC invited state and territorial departments of health and tribal agencies to design creative strategies that would add cardiovascular disease (CVD) screening and lifestyle interventions to breast and cervical cancer screening programmes. Fifteen state and tribal health agencies now operate WISEWOMAN projects (Figure 1).

Using social cognitive theory and the socio-ecological model, WISEWOMAN interventions are tailored to each woman and are designed to improve participants' self-efficacy, self-monitoring, readiness to change, social support, collaborative goal-setting and ability to overcome barriers, by taking small achievable steps. Many projects also use motivational interviewing.[8,9]

Baseline fasting glucose levels appear to be increasing in WISEWOMAN participants (Figure 2), especially in comparison with the levels in the general US population (National Health and Nutrition Examination Study, 1999–2004).[13] Therefore, understanding whether participation in the WISEWOMAN programme improves health outcomes is important for planning diabetes prevention efforts. The goal of this paper is to quantify the baseline prevalence of pre-diabetes and diabetes in WISEWOMAN participants, and assess one-year changes in glucose levels and other heart disease and stroke risk factors.

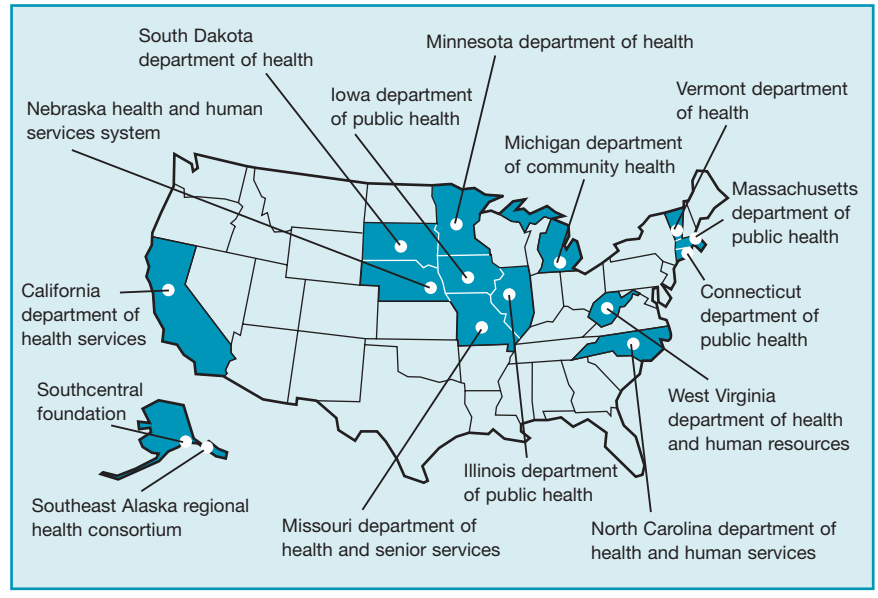

Figure 1. Location of WISEWOMAN projects funded in 2006

Methods

WISEWOMAN projects

We restricted our analysis to the 10 WISEWOMAN projects that offer diabetes and pre-diabetes screenings and, at the time of the analysis, had both baseline and one-year follow-up data on participants.

Data Collection

Programme participants were screened at baseline and again 10–14 months later to assess changes in risk factors. For measurements of BP and cholesterol, WISEWOMAN projects follow guidelines from the Joint National Committee[14] and the Adult Treatment Panel[15] for detection, evaluation and treatment of high BP and cholesterol levels, respectively. For example, all projects measured BP twice during each visit.

At baseline and one-year follow-up, all projects measured height, weight, systolic and diastolic BP, total and high-density lipoprotein (HDL) cholesterol levels, and blood glucose levels. Participants were also asked whether they had ever been diagnosed as having diabetes, high cholesterol, or hypertension and if so, whether they were taking medication to treat these conditions. Participants also indicated whether they smoked cigarettes. The programmes collected demographic data on age, race, Hispanic or Latino origin, and education. The WISEWOMAN data collection protocol has been approved by the RTI International institutional review board.

Definitions

Based on American Diabetes Association guidelines, participants were considered to have pre-diabetes if they had fasting blood glucose levels of 5.5–6.9 mmol/l. They were considered to have diabetes if they had fasting blood glucose levels of ≥7 mmol/l or a self-reported history of diabetes, or if they were taking medication for diabetes.[5] Participants who were newly diagnosed with diabetes were those with abnormal glucose values at baseline (i.e. fasting blood glucose levels ≥7 mmol/l) who reported that they had never been told by a healthcare professional that they had diabetes. Participants with previously diagnosed diabetes were defined as those who reported having been told by a healthcare professional that they had diabetes.[4,5]

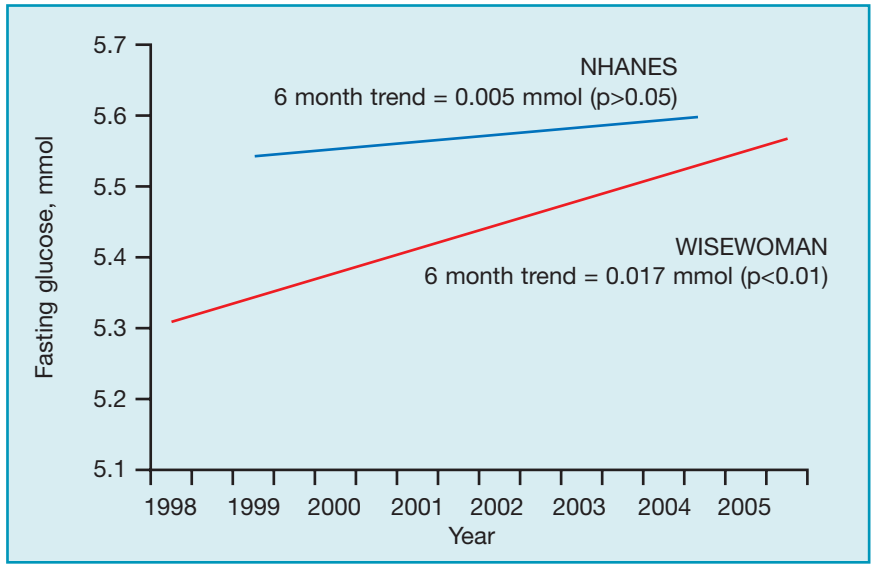

Figure 2. Mean fasting blood glucose values in the US (1999–2004) and in the WISEWOMAN programme (1998–2005)

Measures

We assessed baseline prevalence of pre-diabetes and diabetes and the percentage of newly diagnosed cases of diabetes among 29 387 WISEWOMAN participants screened at baseline between January 1998 (North Carolina is the only project for which screening data are available from 1998. Other projects began screening from 2000 onwards) and June 2005. A total of 23% of programme participants screened at baseline were re-screened one year later. We assessed one-year changes in CHD risk factors (systolic and diastolic BP, total cholesterol, fasting blood glucose, body mass index [BMI], smoking prevalence, and 10-year risk of CHD) in 688 WISEWOMAN participants with baseline pre-diabetes, 83 participants with newly diagnosed diabetes at baseline, and 260 participants with previously diagnosed diabetes.

We calculated the 10-year risk of developing CHD (including angina pectoris, recognised and unrecognised myocardial infarction, coronary insufficiency [unstable angina], and CHD death) with an algorithm developed by Anderson *et al*[16] that uses age, systolic BP, total and HDL cholesterol, diabetes and smoking status as input risk factors. Our rationale for selecting this algorithm was based on our previous work demonstrating the Anderson algorithm to be the most appropriate calculator for tracking changes in CHD risk among WISEWOMAN participants.[17] Age and diabetes status remained unchanged from baseline to follow-up when calculating changes in CHD risk.[17]

Analysis

We estimated one-year changes in risk factors using ordinary least squares regression analysis with the specified risk factor as the dependent variable and the indicator for baseline or follow-up visit as the independent variable. We ran separate regressions for women with baseline pre-diabetes, newly diagnosed diabetes, and previously diagnosed diabetes. To control for correlation among participants who were nested within local project sites, we ran a multilevel mixed model, with participant identification (ID) and state/tribal organisation ID as grouping variables using the *xtmixed* command in Stata.[18,19] P-values ≤0.05 were considered significant.

Results

Demographic characteristics of the WISEWOMAN participants are listed in Table 1. The percentages of women with pre-diabetes and diabetes, including the numbers of those newly diagnosed, are given in Figure 3. The demographic characteristics of the women differed by diabetes status (Table 1).

WISEWOMAN participants who returned for their one-year follow-up examination showed several statistically significant improvements in CVD risk factors (Table 2). Participants with pre-diabetes experienced statistically significant reductions in fasting blood glucose level (by 0.17 mmol/l or 2.9%, p<0.01), total cholesterol level (by 0.11 mmol/l or 2.1%, p<0.01), and 10-year CHD risk (by 4.3%, p<0.05). Participants with newly diagnosed diabetes experienced statistically significant reductions in fasting blood glucose level (by 0.96 mmol/l or 11.5%, p<0.05), systolic BP (by 4.2 mmHg or 3.1%, p<0.05), diastolic BP (by 2.9 mmHg or 3.5%, p<0.05), and total cholesterol level (by 0.36 mmol/l or 6.4%, p<0.01). Participants with previously diagnosed diabetes experienced statistically significant reductions in systolic BP (by 2.5 mmHg or 1.9%, p<0.05), diastolic BP (by 2.7 mmHg or 3.4%, p<0.01), total cholesterol level (by 0.21 mmol/l or 3.8%, p<0 .01), smoking rates (by 3.8 percentage points or 23.8%, p<0.01), and 10-year CHD risk (by 1.1 percentage points or 8.5%, p<0.01).

Discussion

Our results showed that WISEWOMAN participants were at high risk of diabetes-related complications at baseline and that their mean blood glucose values were increasing over time (Figure 2), emphasising the need for programmes like WISEWOMAN, which reduce fasting blood glucose values and control

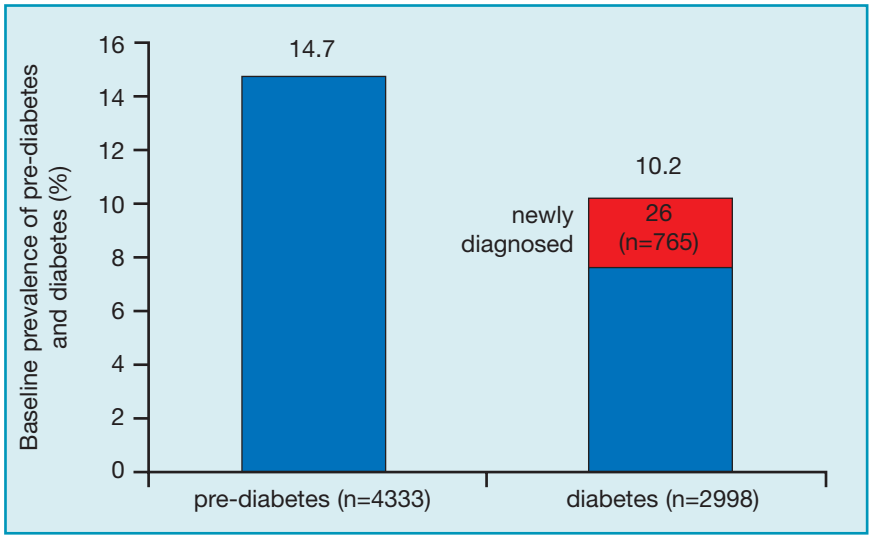

Figure 3. Baseline prevalence of pre-diabetes and diabetes among all WISEWOMAN participants screened at baseline (January 1998–June 2005)

heart disease risk factors among people with diabetes or pre-diabetes.

Results of our analysis are subject to several limitations. First, we do not have data on the changes that would have occurred among this population in the absence of participation in WISEWOMAN projects. An assessment of trends in baseline risk factors (such as those presented in Figure 2 for mean blood glucose values) serves as an imperfect test of whether secular trends are driving the results. A decreasing trend in baseline risk factors across six-month cohorts of newly enrolled participants would suggest that other factors not related to WISEWOMAN may be associated with improvements among participants. However, over this six-year period, baseline blood glucose values among newly enrolled participants have increased significantly (Figure 2) and baseline BP and cholesterol values remained unchanged (trend was not statistically different from zero, results available upon request). Even among the general population of 40–64 year-old women, there is no evidence of decreasing blood glucose values (Figure 2).

Variable	Pre-diabetes (n=688)	Newly diagnosed Diabetes (n=83)	Previously diagnosed Diabetes (n=255)
Age (years)			
<55	62.8	64.2	51.8
≥55	37.2	35.8	48.2
Race or ethnicity			
White	54.6	42.0	55.7
Black	6.4	12.3	14.6
Hispanic/Latina	12.2	21.0	9.1
American Indian/ Alaska Native	23.9	18.5	18.6
Asian	1.3	2.5	0.4
Unknown	1.6	3.7	1.6
Education			
< 12 years	18.2	23.4	18.2
High school graduate	42.2	34.2	45.2
Some college	38.1	39.7	34.2
Missing education	1.5	2.7	2.4

Table 1. Demographic characteristics of WISEWOMAN participants with baseline and follow-up screenings (1998–2005) in 10 projects, by diabetes status (all figures are percentages)

Secondly, it is unclear whether the outcomes were a result of a single programme component or a combination. Evidence suggests that each WISEWOMAN component (i.e. screening, lifestyle intervention, referral services, and one-year follow-up examination) has been effective in similar populations.[4,14,15,20] Furthermore, in our previous work we found that some improvements in CHD risk factors among women with abnormal risk factors at baseline can be attributed to medication use, but most improvements are probably driven by a combination of other factors. These include the receipt of screening, risk factor counselling and lifestyle interventions.[21]

Thirdly, the WISEWOMAN programme has a low follow-up rate (23%). WISEWOMAN participants are recruited from NBCCEDP; as a result, women who lose their eligibility for NBCCEDP because they obtain health insurance, increase their incomes, or reach 66 years of age are automatically ineligible for WISEWOMAN. Although we observed some statistically significant differences in demographic and baseline health characteristics between participants who returned and those who did not return for their one-year follow-up examination, the differences were fairly small (except for smoking

	n	Baseline mean (SE)	Follow-up mean (SE)	Percentage change	p-value for % Δ
Pre-diabetes at baseline					
SBP, mmHg	639	127.9 (0.67)	127.0 (0.65)	–0.7	0.11
DBP, mmHg	637	78.1 (0.41)	77.6 (0.41)	–0.7	0.19
TC, mmol/l	688	5.5 (0.04)	5.4 (0.04)	–2.1	0.00
Glucose, mmol/l	560	6.0 (0.01)	5.8 (0.04)	–2.9	0.00
BMI, kg/m^2	601	32.5 (0.30)	32.3 (0.31)	–0.5	0.26
Smoking, %	676	22.3 (1.60)	21.6 (1.58)	–3.3	0.41
10-year CHD risk, %	602	5.6 (0.17)	5.4 (0.17)	–4.3	0.02
Newly diagnosed diabetes					
SBP, mmHg	81	134.8 (2.15)	130.6 (2.06)	–3.1	0.03
DBP, mmHg	81	81.2 (1.26)	78.3 (1.24)	–3.5	0.02
TC, mmol/l	83	5.7 (0.13)	5.4 (0.12)	–6.4	0.00
Glucose, mmol/l	59	8.4 (0.33)	7.4 (0.35)	–11.5	0.02
BMI, kg/m^2	76	34.4 (1.02)	34.3 (0.87)	–0.3	0.85
Smoking, %	82	13.4 (3.79)	12.2 (3.64)	–9.1	0.71
10-year CHD risk, %	70	12.6 (0.75)	11.6 (0.71)	–8.4	0.07
Previously diagnosed diabetes					
SBP, mmHg	253	131.7 (1.14)	129.2 (1.07)	–1.9	0.03
DBP, mmHg	253	79.0 (0.63)	76.3 (0.57)	–3.4	0.00
TC, mmol/l	255	5.5 (0.07)	5.3 (0.07)	–3.8	0.00
Glucose, mmol/l	128	7.9 (0.28)	7.7 (0.27)	–2.2	0.50
BMI, kg/m^2	236	35.1 (0.51)	35.4 (0.51)	0.6	0.20
Smoking, %	260	16.1 (2.29)	12.3 (2.04)	–23.8	0.01
10-year CHD risk, %	233	12.3 (0.46)	11.2 (0.40)	–8.5	0.00

NOTE: SBP = systolic blood pressure, TC = total cholesterol; DBP = diastolic blood pressure; BMI = body-mass index

Table 2: One-year changes in coronary heart disease (CHD) risk factors, by baseline diabetes status

rates, which were 20% among those who returned and 25% among those who did not return).

Finally, diabetes diagnoses were not confirmed by repeated blood glucose testing on a different day, as recommended by the American Diabetes Association and World Health Organization.[5,7] Also, WISEWOMAN projects are permitted to use venous and capillary methods to measure blood glucose levels.

Our analysis shows that WISEWOMAN participants achieved clinically modest improvements in heart disease and stroke risk factors over a one-year period. If these small reductions could be sustained on a population-wide level, they could lead to large reductions in CHD morbidity and mortality. Moreover, a previous cost-effectiveness analysis of WISEWOMAN has shown that this programme compares favourably with other public health interventions aimed at improving CHD risk factors, even when considering the challenges and barriers of reaching this financially vulnerable population.[22]

Potential barriers to reaching the low-income, under-insured, and uninsured women served by WISEWOMAN include provider skepticism about women's ability to change their behaviours and the women's social isolation, unsafe neighbourhoods and lack of access to healthy foods:[23–26] in some locations, for example, neighbourhood stores do not stock high-quality, affordable fruits and vegetables or low-fat snacks. Because the women face many structural barriers, WISEWOMAN projects are encouraged to use the socio-ecological model[27] to develop multifaceted interventions that address intrapersonal, organisational, community, and policy influences on health and health behaviours. For example, to strengthen family and peer support, which has been shown to improve health outcomes,[28–32] some WISEWOMAN projects now invite relatives and friends to participate in the interventions. WISEWOMAN staff work collaboratively with women to change their behaviours.

Organisations are also developing creative strategies using WISEWOMAN funding.[33] In North Carolina, for example, a county health department clinic partnered with a community free clinic to extend its operating hours so that WISEWOMAN participants could attend appointments more easily. At the community level, some projects have hired community healthcare workers from participants' neighbourhoods to conduct outreach, make telephone calls to encourage attendance at medical examinations and intervention sessions, arrange transportation, help find low-cost medications, and provide other support services. Some projects provide discount passes to encourage exercise in safe environments or discount coupons to community weight-loss programmes.

As WISEWOMAN projects explore ways to serve as agents of social change, they are building alliances among disadvantaged women and their families, healthcare providers, and neighbourhoods. The WISEWOMAN programme's ability to eliminate social-group disparities in diabetes incidence and mortality probably depends on the strength of these alliances. The goal of the WISEWOMAN programme in promoting more comprehensive interventions is to empower women to use all available services, to facilitate the adoption of a healthier lifestyle. The programme also hopes to garner the social support needed for behavioural change, raise providers' expectations, build trust between patients and providers, ensure that healthcare environments address the needs of culturally diverse populations effectively, remove community barriers to healthy lifestyles, and create advocates for better healthcare coverage.

If WISEWOMAN projects can successfully implement multilevel interventions and demonstrate their effectiveness, this approach is likely to be adopted on a much broader scale. As progress is made toward this goal, the WISEWOMAN programme will begin to realise its vision of a world where any woman can access preventive health services and gain the wisdom to improve her health.

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Conflict of interest statement:
None

Disclaimer:
The findings and conclusions in this report are those of the authors and do not necessarily represent the views of CDC or RTI International.

Further information:
Appendices with a summary of the 10 projects, methods for estimating trends in mean fasting glucose values and characteristics of women at one-year follow-up are published online with the article at the European Diabetes Nursing home page on Wiley InterScience – www.interscience.wiley.com

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Appendix A. Selected features the WISEWOMAN programmes.

Feature	Connecticut	Illinois	Massachusetts	Missouri	Nebraska
Year first funded	2000	2001	1995	2003	2000
Lead agency	Connecticut Department of Public Health	Illinois Department of Public Health	Massachusetts Department of Public Health	Missouri Department of Health and Senior Services	Nebraska Department of Public Health
Participant eligibility for intervention	Women with abnormal blood pressure or cholesterol or who use tobacco.	All recruited BCCEDP participants aged 40–64.	Women with abnormal blood pressure or cholesterol, and other CVD risk factors.	All women, regardless of screening results	All women, regardless of screening results
Features of baseline screenings and risk factor assessments	Hypertension, abnormal lipid values, abnormal glucose values, abnormal pulse, overweight, physical inactivity, poor diet, cigarette smoking.	Hypertension, hypercholesterolemia, high triglycerides, abnormal glucose values, abnormal pulse, overweight, abdominal obesity, personal and family medical history, cigarette smoking, poor diet, physical activity.	Hypertension, abnormal lipid values, abnormal glucose values, overweight, physical inactivity, poor diet, cigarette smoking.	Hypertension, abnormal lipid values, abnormal glucose values, overweight, personal and family health history, poor diet, physical inactivity, cigarette smoking.	Hypertension, abnormal lipid values, abnormal glucose values, overweight, personal history, poor diet, physical inactivity, cigarette smoking.
Features of Intervention (nutrition and physical activity)	Adaptation of A New Leaf …Choices for Healthy Living[34] for nutrition; PACE program for physical activity.[35]	A 12-week nutrition and format activity group intervention called Women with Heart (based on Project Active[36]). (A Spanish version, Mujeres con Corazón, is also being used) Sessions with health educators focus on portion sizes, food labels, stress management, and	Individual assessments, education, and lifestyle counseling using the PACE program.[35] Referred to community- based individual or group interventions on nutrition and physical activity.	Nutritionists, health educators or nursing staff use the A New Leaf... Choices for Healthy Living[34] curriculum.	Cooperative Extension nutritionists use ABCs for Good Health,[37] participants receive individually tailored nutrition and physical activity interventions, complete monthly goal assessment, and

Feature	Connecticut	Illinois	Massachusetts	Missouri	Nebraska
		moderate physical activity			10,000 Steps program.[38,39]
Main Outcome Variables	Elevated blood glucose, hypertension and hypercholes-terolemia.	Elevated blood glucose, hypertension and hypercholes-terolemia.	Elevated blood glucose, hypertension and hypercholes-terolemia.	Elevated blood glucose, hypertension and hypercholes-terolemia.	Elevated blood glucose, hypertension, obesity, and hypercholes-terolemia.

Feature	North Carolina	Southeast Alaska Regional Health Consortium	Southcentral Foundation	South Dakota	Vermont
Year	1995	2000	1999	2000	2000
Lead Agency	North Carolina Department of Health and Human Services	SEARHC Community Health Services Division	Alaska Native Medical Center	South Dakota Department of Public Health	Vermont Department of Public Health
Participant eligibility for intervention	BCCEDP participants aged 40–64 who are screened with high serum cholesterol or other abnormal lipids, elevated systolic or diastolic blood pressure or abnormal glucose, or a personal history of these conditions.	All women, regardless of screening results.	All recruited BCCEDP participants aged 40–64 residing within 50 miles of the primary care center.	Preference given to women with abnormal screening results. Women with normal values can self-refer to intervention.	All women, regardless of screening results.
Features of baseline screenings and assessments	Hypertension, hypercholes-terolemia, other abnormal lipids, abnormal glucose values, overweight, personal and family medical history, cigarette smoking, poor diet, physical inactivity. Research site includes the above plus red blood cell membrane fatty acid profiles and blood carotenoids.	Hypertension, abnormal lipid values, abnormal glucose values, overweight, physical inactivity, poor diet, cigarette smoking.	Hypertension, ypercholes-terolemia, high triglycerides, other abnormal lipids, abnormal glucose values, overweight, abdominal obesity, personal and family medical history, tobacco use, poor diet, physical inactivity.	Hypertension, abnormal lipid values, abnormal glucose values, overweight, personal history, physical inactivity, poor diet, cigarette smoking.	Hypertension, abnormal lipid values, abnormal glucose values, overweight, physical inactivity, poor diet, cigarette smoking.
Features of intervention	A New Leaf... Choices for Healthy	Patient educators provide Traditions	A 12-session group covering traditional	There are over 80 lifestyle	Nutritionists use motivational

Feature	North Carolina	Southeast Alaska Regional Health Consortium	Southcentral Foundation	South Dakota	Vermont
(nutrition and physical activity)	Living.[34] In the physical community center site, women also receive follow-up phone calls and reminders from community health workers, and referrals to community resources.	of the Heart (cultural adaptation of A New Leaf… Choices for Healthy Living[34] for Native Alaskan populations) at time of screening. Women also referred to group-based nutrition and physical activity interventions.	wellness, nutrition, physical activity and tobacco education topics, team-taught by nutritionists, exercise physiologists, and health educators. Includes Traditions of the Heart, a cultural adaptation for Alaska Natives of A New Leaf... Choices for Healthy Living.[36] Includes structured diet and physical activity assessments, individual counseling, and tailored goal-setting by health educators.	intervenetionists (e.g. nutritionists, nurses, extension educators) across the state offering A New Leaf … Choices for Healthy Living[34] for nutrition assessment and counseling; physical activity intervention modeled after Project Active.[36]	interviewing to provide individualized counseling that encourage women to adopt healthy lifestyles. They refer to their lifestyle intervention as Turning Over a New Leaf: Healthy Choices from Ladies First.
Main outcome variables	Elevated blood glucose, hypertension and hypercholes-terolemia.	Elevated blood glucose, hypertension and hypercholes-terolemia.	Elevated blood glucose, hypertension and hypercholes-terolemia.	Elevated blood glucose, hypertension and hypercholes-terolemia.	Elevated blood glucose, hypertension and hypercholes-terolemia.

BCCEDP: Breast and Cervical Cancer Early Detection Program; PACE: Physician Assisted Counseling and Evaluation; SEARHC: Southeast Alaska Regional Health Consortium

Appendix B. Mean fasting glucose values in the United States (1999–2004) and in the WISEWOMAN program (1998–2005)

NHANES

We used data from the 1999–2004 National Health and Nutrition Examination Survey (NHANES) Laboratory Assessment: Lab 10AM files from 1999–2000, 2001–2002, and 2003–2004 to estimate average glucose values among U.S. women aged 45–65. We estimated 2-year trends in average fasting glucose values by running a regression on glucose values with examination years (1999–2000, 2001–2002, or 2003–2004) as an independent variable. To account for the complex survey design of the NHANES data, we used svyset and svy: reg commands available in Stata;17 we weighted the estimates with special fasting sample weights and estimated standard errors using appropriate strata and PSU variables. We divided the estimated 2-year trend (0.0021 mmol, p=0.782) in average glucose values by four to obtain a 6-month trend (0.005 mmol). We then plotted average fasting glucose values among U.S. women aged 40-65 for years 1999–2004 using the estimated 6-month trend (Figure 2).

WISEWOMAN

We used 1998–2005 baseline WISEWOMAN data to estimate average fasting glucose values among newly enrolled program participants. We estimated 6-month trends (0.017, p=0.00) in average fasting glucose levels by running a regression on glucose values with baseline screening examination periods as an independent variable. To account for demographic differences among WISEWOMAN cohorts enrolled at different time periods, we controlled for program location and participant age, race or ethnicity, and level of education. We then plotted average fasting glucose values among WISEWOMAN participants for years 1998–2005 using the estimated 6-month trend (Figure 2).

Appendix C. Characteristics of women who return and who do not return for a one-year follow-up visit

The low re-screening rate among WISEWOMAN participants is a concern because women who return might not be representative of the whole WISEWOMAN population, biasing the results. For example, women who return for annual exams might be more likely to take care of their health and be more motivated to change their behavior (e.g., improve their diet or increase their physical activity) than those women who do not return. If so, women who return have greater improvements in risk factors than women who do not and our results overestimate the programmes effectiveness.
To assess the degree of potential bias introduced by low re-screening rates, we assessed differences in demographic and baseline health characteristics between women who do and do not return for an annual follow-up visit (Table C-1). Although some of the differences we found in demographic characteristics were statistically significant, they were fairly small. However, those who return are less likely than those who do not return to smoke at baseline (20% versus 25%) but are more likely to have baseline hypertension (36% versus 34%). These results indicate that it is unlikely that our results were affected by selection bias.

Characteristic	With annual follow-up exam (n=1026)	Without annual follow-up exam (n=3307)	p-value of difference
Age, years	50.5	50.1	0.00
Race or ethnicity (%)			
White non-Hispanic	61	61	0.79
Black non-Hispanic	8	9	0.06
Hispanic	14	15	0.02
Asian/Pacific Islander	2	3	0.00
American Indian or Alaska Native	14	10	0.00
Education (%)			
Less than 9th grade	10	12	0.00
Some high school	10	11	0.08
High school graduate	44	41	0.00
Some college or higher education	36	36	0.96
Health status (%)			
Hypertension (BP ≥140/90 or meds)	36	34	0.03
Abnormal total cholesterol level (TC ≥240 or meds)	28	26	0.06
Diabetes (FG ≥126, NFG ≥200, self-reported diagnosis, or taking medications for diabetes) (%)	9	10	0.07
Obese (BMI ≥30) (%)	33	33	0.89
Smoker (%)	20	25	0.00

BP: blood pressure; TC: total cholesterol; FG: fasting glucose; NFG: nonfasting glucose; BMI: body-mass index.

Table C-1. Baseline demographic and risk factor characteristics of WISEWOMAN participants with and without follow-up exams