### Title

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# Computer-Assisted Diabetes Risk Assessment and Education (CADRAE) for Medically Vulnerable Populations in the Middle East: a Novel and Practical Method for Prevention

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## Abstract

The prevalence of diabetes in the Middle East is increasing rapidly due to urbanization, reduced levels of physical activity, and a nutritional transition toward increased consumption of fats and refined carbohydrates. Preventive strategies are of paramount importance to stemming the tide. Portable touch-screen computer technology may hold an answer for alleviating the burdens of cost, time, and training that limit the implementation of diabetes risk screening and intervention, especially among refugees and other vulnerable populations. The Computer-Assisted Diabetes Risk Assessment and Education (CADRAE) Arabic-language intervention program is proposed as a model method for practicing proactive type 2 diabetes prevention in resource-limited settings of the Middle East that combines the efficiency of risk-score screening methods, the advantages of portable computer interface, and the spirit of brief motivational interviewing. This paper aims to describe the theory and novel design of CADRAE—introduced at the Noor Al Hussein Foundation's Institute of Family Health in January 2014—as well as discuss opportunities and challenges for its implementation and evaluation in primary or emergency care settings. Features of CADRAE are elucidated in detail, including development, translation, conceptual framework, theoretical basis, method of risk assessment, brief intervention style, definition of outcomes, requirements for implementation, and potential means of evaluation and quality improvement. CADRAE offers the first example of portable computer technology integrating diabetes risk screening with behavior change counseling tailored for an Arabic-speaking population of mostly refugees and could offer a valuable model for researchers and policy makers of the Middle East as well as other resource-limited settings.

## Introduction

The global burden of diabetes is immense and growing. In 2013, there were an estimated 382 million people living with diabetes, far surpassing previous projections, and the number

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is expected to rise to 592 million by 2035 [1-3]. The overall prevalence of type 2 diabetes in the Middle East is particularly high (10.5%) and predicted to have the greatest relative increase in prevalence worldwide by 2030 [3,4]. Factors contributing to these high rates include rapid urbanization, reduced levels of physical activity, and a nutritional transition toward increased consumption of fats and refined carbohydrates [5,6]. Moreover, political instability and conflict in the region have produced unprecedented numbers of urban refugees, whose risks are exacerbated by limited health services and resources, cultural and language barriers, and inadequate attention by both host countries and the international community toward non-communicable disease prevention and management [7,8]. As a result, diabetes has become a major public health threat to individuals and communities as well as a heavy economic burden on countries in the region.

Preventive strategies are important to addressing the rising personal and societal costs of diabetes in the Middle East. Several intervention studies and clinical trials, including in Middle Eastern populations, have shown that type 2 diabetes is preventable among individuals at high risk through control of diet and exercise [9-13]. Thus, identifying high-risk individuals for targeted intervention may contribute toward effective preventive efforts. Most current risk screening methods require biochemical tests that need specialized training to perform and are invasive or time-consuming [14]. Risk scores, on the other hand, predict probability of developing diabetes based on the presence of causal risk factors and offer a safe, convenient, and cost-effective alternative [15].

Furthermore, previous studies on diabetes prevention through lifestyle modification have relied on highly intensive interventions, including multiple individual and group counseling sessions led by professional nutritionists, dieticians, behavioral psychologists, and exercise physiologists [11,12]. Staff shortages and financial constraints would limit the feasibility and sustainability of such interventions. The less intensive model of motivational interviewing, a patient-centered technique for behavior change that has produced significant lifestyle changes and weight loss in previous trials, may help address these constraints [16-20]. Broad implementation of even brief motivational interventions, however, can encounter major obstacles; training in motivational interviewing may have only temporary or insufficient effects on the behavior of clinicians, who often lack sufficient time, confidence, or investment to carry out preventive interventions [21-23].

Portable computer technology may hold the answer for alleviating the aforementioned burdens of cost, time, and training that limit the implementation of both risk screenings and brief interventions for diabetes prevention. Computer-aided approaches require minimal training, time, and effort from health care personnel while taking advantage of patient wait time, commonly viewed as time wasted, for screening and health promotion [24]. They are relatively inexpensive to maintain, accessible regardless of preferred language, implementable by non-health professionals, and replicable in nearly any setting. Even vulnerable populations such as urban refugees, despite being widely dispersed and mobile, could feasibly be reached when seeking medical services through opportunistic intervention employing a computer-assisted approach in the primary or emergency care setting.

The Computer-Assisted Diabetes Risk Assessment and Education (CADRAE) Arabic-language intervention program is proposed as a model method for practicing proactive type 2 diabetes prevention in resource-limited settings of the Middle East that combines the efficiency of risk-score screening methods, the advantages of portable computer interface, and the spirit of brief motivational interviewing. The CADRAE method was developed by the University of California, Irvine (UCI) School of Medicine in partnership with the Noor Al-Hussein Foundation's Institute for Family Health (IFH). The IFH Clinic is located in the Sweileh district of Amman, Jordan, and provides health services for a population that includes medically vulnerable Jordanians as well as Syrian, Palestinian, and Iraqi refugees. This paper aims to describe in detail the theory and novel design of the CADRAE method as well as discuss opportunities and challenges for its implementation and evaluation in the primary or emergency care setting.

## Methods

### Brief Overview

CADRAE facilitates the quick and effective screening of Arabic-speaking patients for risk of developing type 2 diabetes and the provision of high-risk patients with a brief motivational intervention aimed at lifestyle modification that is also relevant for the context of vulnerable populations in the Middle East. This study was carried out in accordance with the Institutional Review Board at the University of California, Irvine, and was consistent with Federal guidelines. The IFH Clinic introduced the CADRAE program into its Family Medicine and Women's Health divisions in January 2014. At the IFH Clinic, CADRAE requires less than 15 minutes and is administered using a portable touch-screen PC that may easily be held by either the patient or facilitator. The facilitator may help administer CADRAE to those patients unable to read or operate the touch-screen computer for themselves, allowing maximum accessibility. CADRAE consists of two main segments: the risk assessment module and the motivational intervention module. The content of each is further elucidated below, and the overall iterative process of inclusion, screening, and intervention is summarized in Figure 1.

### Translation

The CADRAE script employed by IFH was written in English and translated into Arabic with professional services of the Noor Al Hussein Foundation. The result was verified by faculty of the Qasid Arabic Institute in Amman, Jordan, by way of back-translation. Face validity of the CADRAE script was enhanced by a panel review to assess whether questions measured what was intended. The panel included three members: a physician of the IFH Family Medicine division, a senior nurse of the IFH Women's Health division, and an instructor of the Qasid Modern Standard Arabic program. Each panel member also reviewed CADRAE to assess its clarity and relevance before offering point-by-point recommendations, and the Arabic script was revised accordingly. Revisions included changes to the syntax of question translations as well as modification of the list of recommended behavior change goals to be more relevant to IFH patients. The final CADRAE design as practiced by IFH was thus tailored for cultural appropriateness to the Arabic-speaking populations of Jordan.

## Risk Assessment Module

**Eligibility Screening and Consent—**The CADRAE facilitator first seeks to establish rapport by approaching potential subjects with open-ended questions that demonstrate concern, such as how they are feeling and whether they are comfortable. Next, the facilitator raises the subject by requesting permission to provide the patient with a very brief heath screening related to risk of developing diabetes. Patients who are minors, pregnant women, or previously diagnosed with diabetes, for whom the questionnaire employed by CADRAE is not valid or applicable, are excluded as well as those who decline partaking in CADRAE or are too medically unstable to provide consent. After confirming eligibility and obtaining verbal consent, the facilitator provides the patient with the tablet computer and initiates the CADRAE program.

**Diabetes Risk Screening—**The CADRAE program opens with a brief introduction followed by a diabetes risk screening that utilizes a simple interface for user control, as pictured in Figure 2. This risk screening module delivers a self-administered computerized questionnaire based on FINDRISC, a validated evidence-based tool recommended by the International Diabetes Federation and multiple international bodies [25-27]. In a recent evaluation, FINDRISC was positively associated with prevalence of prediabetes (OR = 1.15 for 1 unit increase, $p<0.001$), and the area under ROC for detecting prediabetes was 0.67 ($p<0.001$) [28]. FINDRISC was developed in 2001 for self-assessment of diabetes risk among non-pregnant adults using eight scored questions, with a total score between 0 and 26 measuring probability of developing type 2 diabetes within 10 years. The test takes only a few minutes to complete and is easily adapted to computer format. Eight variables strongly correlated with risk of diabetes are included in the test: age; body mass index (BMI); waist circumference; use of anti-hypertensive medication; history of elevated blood glucose; family history of diabetes; and meeting of criteria for daily physical activity and daily consumption of fruits and vegetables. Total risk score is further stratified into five categories, displayed in Table 1, which correspond to levels of risk for developing diabetes within 10 years.

CADRAE presents the FINDRISC questions to the patient one at a time followed by a prompt to return the computer tablet to the CADRAE facilitator. The patient's height, weight, and waist circumference may be obtained by the facilitator either from medical records or from measurement in the privacy of a separate room. The facilitator enters these values into CADRAE, which calculates the patient's FINDRISC score, before returning the computer tablet to the patient. If the patient is found to be at low risk (FINDRISC score <7), CADRAE presents to them their results, reminders of the importance of physical activity and healthy diet to preventing diabetes, and a concluding screen thanking them for their participation. For patients at elevated risk, CADRAE proceeds to the motivational intervention module.

## Motivational Intervention Module

**Principles of the Intervention—**The self-administered CADRAE motivational intervention module was constructed using information from the American Diabetes Association's Patient Education Toolkit for reducing cardiometabolic risk, designed for

distribution to patients and available online [29]. More specifically, the bulk of the educational and goal-setting content of CADRAE was based on *Toolkit No. 3: All About Prediabetes* and *Toolkit No. 4: Learning How to Change Habits*, which focus on modifiable risk factors for diabetes. The resulting brief intervention consists of three basic components: (1) readiness-to-change assessment, (2) arguments for change and goal-setting, and (3) one month telephone follow-up.

Motivational interviewing was developed as a directive, patient-centered counseling style that assists the patient to explore and resolve ambivalence about behavior change while avoiding confrontation and supporting optimism for change [16]. The principles of motivational interviewing, as summarized in Table 2, were the basis of the style and design of each of the three components of the CADRAE motivational intervention module.

**Readiness-to-Change Assessment—**A clear distinction is made between the objective outcome of FINDRISC, presented to the patient in non-judgmental language, and the subsequent interpretation or relevance of that outcome, which is instead elicited from the patient. CADRAE first addresses the patient's perceived susceptibility and severity with regard to diabetes, as emphasized by the Health Belief Model, through a presentation of the patient's elevated risk screening result as well as basic facts about the prevalence and complications of pre- and type 2 diabetes [30]. CADRAE then elicits the patient's numerical judgment of their readiness to change using a ten-point rating scale, as shown in Figure 3. To avoid resistance, the intervention continues in its entirety for only those patients who choose a readiness score of 4 or above, since confrontation may exacerbate risk behaviors by having a negative effect on patient self-efficacy [3,32]. Those patients found to be unsure about change are instead encouraged to reflect on their perceived benefits and barriers to lifestyle modification before the program concludes with supportive language that affirms personal autonomy and control.

**Arguments for Change and Goal-Setting—**For those patients with moderate to high readiness-to-change scores, CADRAE displays prompts to encourage reflection on reasons why reducing risk of diabetes would be important to them. The benefits of lifestyle modification are presented in optimistic language. This component of the CADRAE intervention aims to enhance the motivation essential for behavior change by eliciting arguments for change from the patient. CADRAE proceeds to build patient confidence through practical, attainable goal-setting. The patient is invited to select strategies they would like to attempt among lists of optional lifestyle modification goals, such as the list displayed in Figure 4. Steps chosen by the patient for increasing physical activity and improving diet are reflected back to the patient, thereby emphasizing that the choice to change behavior belongs to the patient.

To reinforce self-efficacy, CADRAE displays encouraging messages endorsing the patient's potential to change and provides practical support by prompting the patient to think through a realistic, achievable plan. As posited by Social Learning Theory, a patient-centered approach that encourages direct patient involvement in setting goals is likely to support an effective therapeutic session [31]. In CADRAE, this consists of posing specific questions about the action or habit, including what the patient will do, when he/she will do it, what is

needed to get ready, what might get in the way, and what the patient will do instead if faced with this obstacle. At this point, CADRAE concludes with messages expressing appreciation for the patient's participation and encouraging patience and persistence in chosen goals.

**One Month Telephone Follow-up—**The IFH Clinic employs follow-up contact by telephone to provide further support of behavior change goals. Due to widespread use of cellular mobile telephones in Jordan, including among urban refugees, contact by telephone is a feasible method of follow-up. They are conducted by IFH nurses one month following administration of CADRAE and last no more than a few minutes. Follow-up support consists of reminding the patient of their participation in CADRAE and asking open-ended questions regarding progress on attaining goals of increased physical activity and improved diet. The conversation and questions are framed in the spirit of continued interest in and concern for the patient as a person. While this practice is specific to the IFH Clinic and is not an essential component of CADRAE, ongoing support for behavior change is consistent with the principles of motivational interviewing and may be implemented in a format and manner best suited to clinic resources and patient population, whether by phone call, text message, email, clinic re-visit, or home visit.

## Outcomes

Within the conceptual framework of CADRAE, as diagramed in Figure 5, there exist three types of intermediate outcomes that may be used to evaluate the effectiveness of any given adaptation of the CADRAE method. The first is direct changes in patient motivation to change or self-efficacy, which could possibly be measured qualitatively or through scaled questions. The second type is behavioral changes, such as increased physical activity or reduced consumption of fats or calories. Examination of lifestyle modification may include the magnitude and duration of these behavioral changes following administration of CADRAE. For example, the IFH presently plans to assess CADRAE on the basis of intermediate outcomes, namely change in FINDRISC risk score attributable to physical activity and diet one month after administration. The final intermediate outcome is biometric or biochemical screening values, namely changes to patients' BMI, waist circumference, fasting plasma glucose (FPG), 2-hour oral glucose tolerance test (OGTT) result, or HbA1c test result. These intermediate outcomes would be the most time-consuming, invasive, and expensive to examine and require the longest follow-up period.

Whether to evaluate a CADRAE adaptation on the basis of its primary target health outcome —incidence of type 2 diabetes—or any of these various intermediate outcomes depends on the setting of its implementation. Consideration should be given to what outcome measures would be most feasible and appropriate to assess given the healthcare resources available and the patient population being served. For instance, among refugees or other vulnerable populations in the Middle East, it may be too ambitious to expect drastic and immediate changes in behavior or to attempt long-term follow-up; measures of patient motivation instead may be more appropriate and show the strongest effects [33].

Alternatively, the CADRAE method may be evaluated against traditional barriers to diabetes risk screening and intervention that it was designed to overcome, including the system-,

patient-, and provider-based barriers listed in Figure 5. This may consist of feasibility studies examining the cost-effectiveness and time burden of integrating CADRAE into the primary or emergency care setting. Additionally, process evaluation strategies such as focus groups, interviews, or direct observations may provide further insight into the acceptability and usability of CADRAE among patients and providers. The computer-assisted approach lends itself to both electronic data collection and continuous quality improvement, as the software could easily be reprogrammed to modify screening or intervention components according to rigorous study of their efficacy.

## Discussion

The integration of diabetes risk screening with behavior change counseling by way of portable computer technology could offer a valuable model for other resource-limited settings where lack of finances and personnel limit the implementation of preventive strategies. The CADRAE implementation program at IFH represents the first example of such integration tailored for an Arabic-speaking population consisting primarily of refugees and could be implemented widely across the Middle East, where policy makers struggle to address rising rates of diabetes prevalence and growing populations of urban refugees. Due to its compatibility with opportunistic deployment during patient wait time, CADRAE may prove feasible for adaptation to various health care settings.

It may be argued that, while the computer-assisted approach is convenient, CADRAE may compromise the interpersonal basis of motivational interviewing as well as create an additional barrier of computer literacy. The use of touch-screen interface, however, minimizes the need for computer literacy on the part of the patient, while adjunctive strategies, such as the ongoing support of follow-up telephone calls, may supplement CADRAE and help mitigate any negative effects of its less personal computer design. Moreover, computer-based interventions have already shown promising results with regard to behavior change related to smoking and alcohol use [34,35]. Computerized designs also offer unique advantages; computer interface can result in more positive responses to questions about stigmatized behaviors than face-to-face interviews, as greater patient anonymity facilitates less social desirability bias and more self-disclosure 36-38]. Finally, the CADRAE method makes feasible the practice of proactive diabetes screening and health education that would otherwise be inaccessible to medically vulnerable patients in the Middle East.

A number of challenges to implementation of the CADRAE model must be highlighted, most notably the need to tailor the risk assessment and intervention content to specific settings and populations. Performance of risk scores developed in Caucasian populations, for example, may vary widely among populations of diverse ethnic origins [39]. Additionally, researchers and practitioners must be intimately familiar with the population being served to design an intervention that is relevant and culturally appropriate [33]. In the IFH experience, preliminary work obtaining feedback from practitioners and patients was necessary for developing an intervention suitable to the setting. Nevertheless, the capacity for wide-reaching implementation of computer-assisted approaches such as CADRAE provides a

novel, although unproven as of yet, potential for population impact that should be thoroughly explored.

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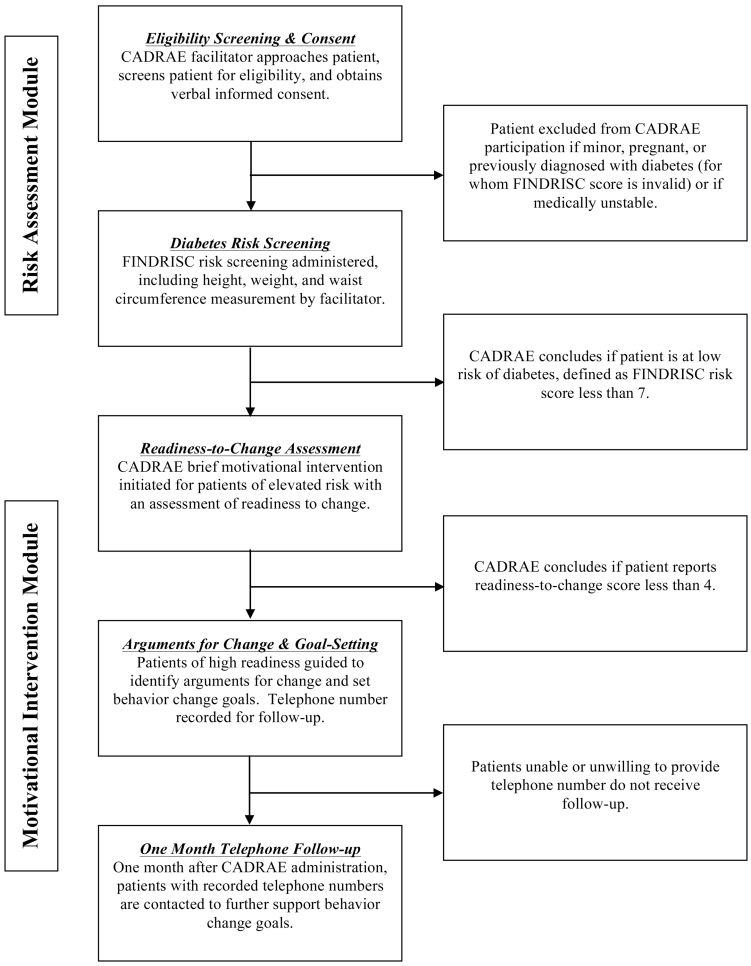


**Figure 1. Flowchart of CADRAE method as practiced at IFH Clinic**

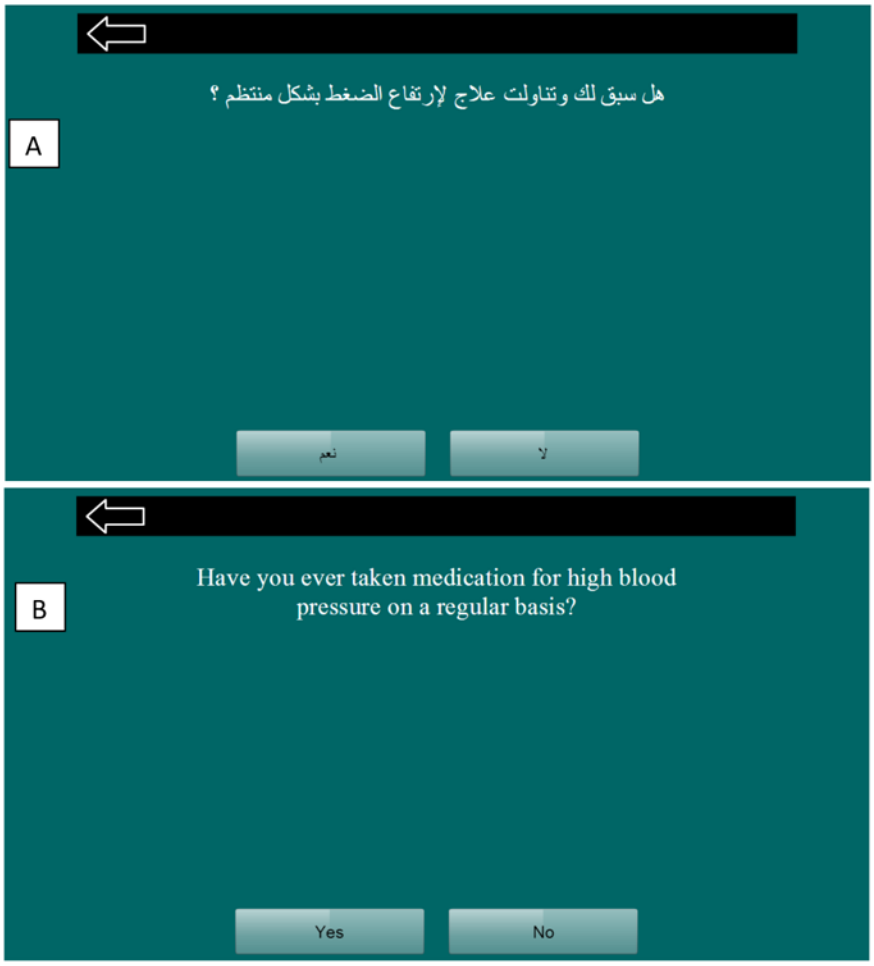


**Figure 2. (A) Sample screenshot of question from CADRAE risk assessment module; (B) English translation of sample**


**Figure 3. (A) Sample screenshot from CADRAE readiness-to-change assessment; (B) English translation of sample**


**Figure 4. (A) Sample screenshot from CADRAE goal-setting component; (B) English translation of sample**

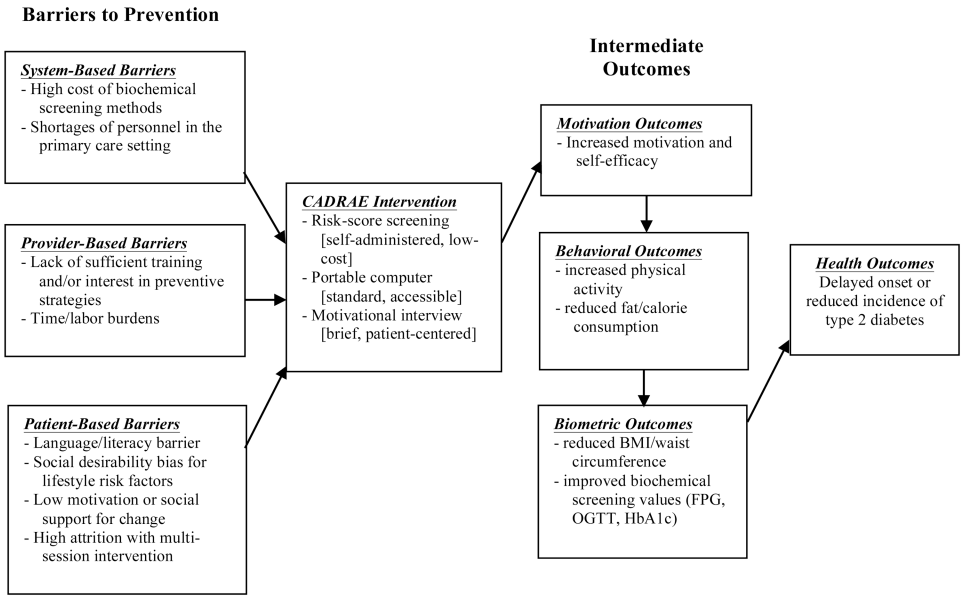


**Figure 5. Conceptual framework for evaluation of CADRAE method and outcomes**

**Table 1**

**FINDRISC Risk Categories**

| Total Risk Score | Risk Category | Description |
|---|---|---|
| < 7 | Low | estimated 1 in 100 will develop disease |
| 7–11 | Slightly Elevated | estimated 1 in 25 will develop disease |
| 12–14 | Moderate | estimated 1 in 6 will develop disease |
| 15–20 | High | estimated 1 in 3 will develop disease |
| > 20 | Very High | estimated 1 in 2 will develop disease |

## Table 2

**Principles of motivational interviewing[a]**

| |
|---|
| The interview seeks to mobilize the client's intrinsic values and goals to resolve ambivalence and stimulate behavior change. |
| The therapeutic relationship is treated as a partnership rather than an expert/recipient relationship. |
| Motivation to change is elicited from the client rather than imposed upon him/her from without. |
| Readiness to change is understood as a fluctuating product of interpersonal interaction rather than a client trait. |
| The client's belief in ability to carry out and successfully achieve a specific goal is elicited and reinforced. |

[a] Adapted from Miller and Rollnick [16].