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# The proportion of dementia attributable to common modifiable lifestyle factors in Barbados

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**ABSTRACT**

**Objective.** *To understand what number and proportion of dementia cases in Barbados are attributable to modifiable lifestyle factors and what effect a reduction in these risk factors would have on future dementia prevalence.*

**Methods.** *This was an observational study using Levin's Attributable Risk formula, which assumes independence of risk factors, to calculate the population attributable risk (PAR) of dementia (all-cause) for six risk factors: midlife obesity, physical inactivity, smoking, low educational attainment, diabetes mellitus, and midlife hypertension in Barbados. A recently-published, modified formula was utilized to account for non-independence of risk factors using secondary data for Barbados. The number and proportion of dementia cases attributable to each risk factor and to all risk factors combined were computed, as was the effect that any reduction in these risk factors might have on future dementia prevalence.*

**Results.** *Accounting for the fact that risk factors do not operate independently, 50.9% (1 526 cases) were attributable to the combined effect of the six risk factors under study. According to the analysis, if each risk factor were reduced by 5% – 20% per decade, dementia prevalence could be 3.3% – 31.8% lower by 2050.*

**Conclusion.** *Using a largely theoretical model, the six modifiable lifestyle factors were estimated to be attributable to 50.9% of dementia cases in Barbados. Since the risk factors have much in common, any intervention that targets one of them could significantly reduce future dementia prevalence.*

**Keywords** Prevention & control, dementia; health behavior; Barbados.

Dementia is a progressive condition characterized by declines in memory, communication ability, and behavior (1). There is no known cure, and age is presently its strongest known predictor (2, 3). Over 40 million people worldwide are estimated to have the condition (1). This figure is projected to increase to over 110 million by 2050 (4), heavily influenced by rapidly aging populations, particularly in low- and middle-income countries (5). Diabetes, hypertension, smoking, alcohol consumption, education level, diet, and physical activity habits have all been identified as risk factors for dementia (6 – 8). These factors are modifiable and have the potential to reduce dementia risk.

Numerous studies have investigated the effects of risk factor prevalence on

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development of dementia in high-income countries (9 – 11). In contrast, little is known about the effects in developing countries, such as those of Latin America and Caribbean where an estimated 44% of people living with dementia reside (12). These countries are known to have limited resources and a shortage of elder-care services, especially for those living with dementia and their caregivers (12).

Any intervention able to delay or prevent the onset of dementia by targeting modifiable lifestyle factors has the potential to significantly reduce its future prevalence (13) and the need for dementia-related health services and support. By calculating the population attributable risk (PAR), researchers can quantify the magnitude and societal impact of a known risk factor and the development of a particular disease.

The objective of this study was to calculate the PAR for dementia (all-cause) in Barbados, accounting for both independence and non-independence of six modifiable lifestyle factors known to be associated with dementia (10, 14 – 16). A secondary aim was to estimate the effects of reduction in risk factor prevalence every 10 years through 2050 on future dementia prevalence in Barbados.

**TABLE 1. Risk factor definitions used for the calculation of population attributable risk (PAR) of dementia for six modifiable lifestyle factors in Barbados, 2010**

| Risk factor | Definition for PAR |
|---|---|
| Mid-life obesity | Proportion of adults (45 – 64 years of age) with a body mass index ≥ 30 |
| Physical inactivity | Proportion of adults not meeting physical activity guidelines (< 150 minutes of moderate intensity per week) |
| Smoking | Proportion of adult smokers |
| Low educational attainment | Proportion of adults with < a secondary school education |
| Diabetes mellitus | Adult prevalence of type 2 diabetes mellitus |
| Mid-life hypertension | Prevalence of hypertension in adults (45 – 64 years of age) |

***Source:*** Risk factor definitions based on those of Barnes and Yaffee (20).

**TABLE 2. Relative risk data used in calculation of population attributable risk (PAR) of dementia for six modifiable risk factors in Barbados, 2010**

| Risk factor | Population prevalence of risk factor | Relative risk for dementia (95%CI) [a] | Communality/shared variance among risk factors |
|---|---|---|---|
| Mid-life obesity | 34.6% | 1.64 (1.34 – 2.00) | 0.1551 |
| Physical inactivity | 49.9% | 1.39 (1.16 – 1.67) | 0.1172 |
| Smoking | 9.2% | 1.28 (0.99 – 1.60) | 0.2108 |
| Low educational attainment | 25.5% | 1.72 (1.52 – 1.96) | 0.0345 |
| Diabetes mellitus | 18.7% | 1.50 (1.33 – 1.70) | 0.2649 |
| Mid-life hypertension | 52.9% | 1.61 (1.16 – 2.24) | 0.2729 |

***Source:*** Prepared by the authors from the study results using the population prevalence of risk factor findings of Howitt and colleagues (17) and the relative risk for dementia according to the World Alzheimer's Report 2014 (16).
[a] 95% Confidence Interval.

## MATERIALS AND METHODS

This was an observational study conducted in Barbados, an independent country in the English-speaking Caribbean with a population of slightly more than 285 000. The population of Barbados is primarily composed of African descendants, but also has ethnic variations due to European and Indian ancestry.

### Risk factors

Six modifiable lifestyle factors were selected: midlife obesity, physical inactivity, smoking, low educational attainment, diabetes mellitus, and midlife hypertension. These were chosen because they are known to be associated with dementia (10, 14 – 16) and the relevant data are readily available and accessible.

### Data sources

PAR is calculated by using the population prevalence (P) of a risk factor (obtained from census/survey data) and the relative risk (RR) of that risk factor with a particular outcome.

This study used three secondary data sources to perform calculations. The first source, by Howitt and colleagues (17), provided country-specific risk factor prevalence data on the distribution of diabetes, hypertension, and related risk factors by gender, education, and occupation among adults in Barbados. The cross-sectional survey utilized by this source targeted individuals 25 years of age and over in households selected from a national sampling frame maintained by the Barbados Government Statistical Service. Data were collected from September 2011 – May 2013.

The second source, the 2014 World Alzheimer's Report (16), provided global, relative risk data.

The third was the "Survey on Health, Well-being and Aging in Latin America and the Caribbean" (SABE; 18). These data were used to determine the shared variance among risk factors, a key element to consider when accounting for non-independence of risk factors. Conducted in 1999 – 2000, SABE aimed to examine health conditions and health-related disability among persons in seven Latin American and Caribbean countries (Argentina, Barbados, Brazil, Chile, Cuba, Mexico, and Uruguay), with special emphasis on those 60 years of age and over. SABE is widely used and is the only survey with data on such an extensive range of health-related variables for the age group of interest and for a country within the English-speaking Caribbean. SABE datasets are freely available from the International Consortium for Political and Social Research (18).

Table 1 provides the definitions for each of the six risk factors included in the study. These definitions are in keeping with other published work (19).

### Data analysis

Table 2 highlights some of the key data needed for the PAR calculations on dementia in Barbados, including the six

risk factors, the population level prevalence of the risk factor (17), the relative risk for dementia in relation to examined risk factors (16), and the communality/shared variance among the six examined risk factors. The variance was calculated using SABE data and Stata®/MP12 (Stata Corp LP, College Station, Texas, United States) statistical software.

Estimates of the PAR of dementia for each of the six risk factors were calculated using Levin's Population Attributable Risk formula, which assumes independence of risk factors (19):

$$PAR = [P \times (RR - 1) / (1 + P \times (RR - 1))]$$

where $P$ is the population prevalence of the risk factor, and RR is the relative risk.

Still assuming independence of risk factors, the combined effect of the PAR estimates was estimated using the following formula (20):

$$\text{Combined PAR} = 1 - \prod 1 - PAR$$

To account for the interrelationship among the six risk factors, a previously published formula was used (21):

$$PAR_{Adjusted\ Combined} = 1 - \prod 1 - (w \times PAR)$$

More specifically, Stata®12 was used to generate a matrix of tetrachoric correlations, and subsequently, to perform exploratory factor analysis using the matrix as input to determine the shared variance and the uniqueness ($w$) of all six risk factors. Similar to other studies, the Kaiser criterion was used for selecting the number of factors to retain during factor analysis (21).

Total number of dementia cases related to each of the six risk factors was calculated as the product of their individual PARs and dementia prevalence.

The effect of reducing the relative prevalence of all risk factors by 5%, 10%, 15%, or 20% every decade until 2050 in Barbados was calculated using estimates (12). Due to limitations in the availability of dementia prevalence data for each decade, the percentage reduction in risk factor prevalence was based on a compound-interest formula:

$$A = P\left(1 + \frac{r}{n}\right)^{nt}$$

where $A$ represents the computed number of dementia cases taking into consideration risk factor reduction; $P$ is the projected number of dementia cases obtained from published work; $r$ is the decrease in risk factor prevalence (in this case 5%, 10%, 15%, 20%); $n$ is the number of times the risk factor prevalence is decreased per decade (in this case, 1); and $t$ is the number of years (in this case, 10 years).

**TABLE 3. Population attributable risk of dementia for each risk factor and number of cases attributable of the total estimated number of dementia cases ($n$ = 3 000) in Barbados, 2010**

| Risk factor | % population prevalence of risk factor | % estimated population attributable risk (95% CI)[a] | Number of attributable cases in 2010 (95% CI) |
|---|---|---|---|
| Midlife obesity | 35 | 18.3 (10.6 – 25.9) | 549 (319 – 778) |
| Physical inactivity | 50 | 16.3 (7.4 – 25.1) | 490 (222 – 753) |
| Smoking | 9 | 2.5 (-0.01 – 5.1) | 74 (-3 – 153) |
| Low educational attainment | 17 | 10.9 (8.1 – 14.0) | 327 (244 – 421) |
| Diabetes mellitus | 19 | 8.0 (3.7 – 12.8) | 241 (110 – 383) |
| Midlife hypertension | 53 | 24.4 (7.8 – 39.7) | 733 (235 – 1 190) |
| Combined | | 58.7 (32.4 – 76.2) | 1 761 (973 – 2 285) |
| Adjusted combined | | 50.9 (28.0 – 67.5) | 1 526 (840 – 2 024) |

[a] 95% Confidence Interval.

***Source:*** Prepared by the authors from the study results, using the population prevalence of risk factor findings of Howitt and colleagues (17).

## RESULTS

### Assuming risk factors operate independently

Both the proportion and number of dementia cases attributable to each of the six risk factors in 2010 are presented in Table 3. Estimates showed midlife hypertension to be related to the greatest proportion of dementia cases when compared to the other risk factors (24.4% of dementia cases). Assuming that each risk factor exerts an individual effect, they were estimated to account for a combined 58.7% of dementia cases in Barbados (1 761 cases).

### Accounting for non-independence of risk factors

Data from SABE was used to estimate the shared variance for all risk factors under study (Table 2, column 4). When the interrelationship among risk factors was considered (i.e., the adjusted combined PAR shown in Table 3), 50.9% (1 526 cases) of dementia cases were estimated to be attributable to the six risk factors under study.

### Effect of risk factor reduction

Table 4 and Figure 1 show the effects of reductions in each risk factor—by 5%, 10%, 15%, and 20% each decade—on dementia prevalence in 2010 – 2050. In Table 4 shows both the projected number of dementia cases and the percentage reduction in dementia cases resulting from risk factor reduction are shown. According to the study estimates, if each risk factor were reduced by 5% – 20% every 10 years, dementia prevalence in Barbados would be reduced by as much as 15.2% in 2030 and 31.8% in 2050.

## DISCUSSION

Accounting for the interrelationship among risk factors, over one-half of dementia cases in Barbados could be attributed to the six lifestyle factors studied. We determined that dementia risk-reduction programs have the potential to diminish future dementia prevalence significantly, by up to 31.8%.

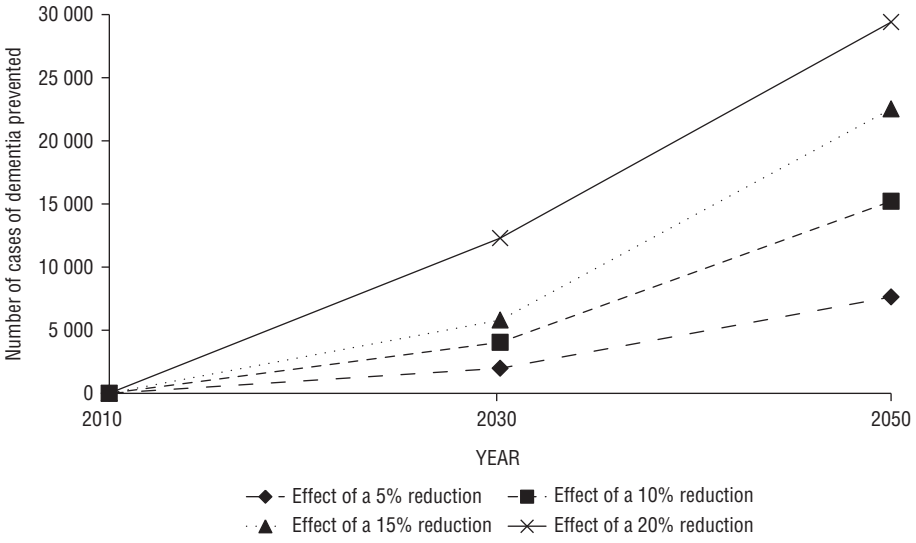
The high prevalence of midlife hypertension, midlife obesity, and physical inactivity in Barbados led to the study finding that these factors account for a significant proportion of dementia cases

**TABLE 4. Estimated effect of a 5%, 10%, 15%, and 20% per decade reduction in all six modifiable lifestyle risk factors (midlife obesity, physical inactivity, smoking, low educational attainment, diabetes mellitus, and midlife hypertension) on future dementia prevalence in Barbados, 2010 – 2050**

| Percent reduction | Year | | | | |
|---|---|---|---|---|---|
| | 2010 | 2030 | | 2050 | |
| | | *n* | % | *n* | % |
| Estimated/projected dementia cases | 3 000 | 71 000 | 100.0 | 138 000 | 100.0 |
| 5% decrease | NA | 68 748 | 3.3 | 129 345 | 6.7 |
| 10% decrease | NA | 66 430 | 6.9 | 120 761 | 14.3 |
| 15% decrease | NA | 64 430 | 10.8 | 112 472 | 22.7 |
| 20% decrease | NA | 61 646 | 15.2 | 104 681 | 31.8 |

***Source:*** Prepared by the authors from the study results, except data for year 2010 which came from a report produced by Alzheimer's Disease International and British United Provident Association (12).

**FIGURE 1. Reduction in dementia cases as a result of a 5%, 10%, 15%, and 20% per decade reduction in each risk factor (2010 – 2050)**




***Source:*** Prepared by the authors from the study data.

(24.4%, 18.3%, and 16.3%, respectively). Midlife hypertension was found to attribute to the greatest proportion of dementia cases. This is in contrast to the findings of two other studies, one that utilized risk factor prevalence data for the United Kingdom, Europe, and the United States of America (21), and the other, from Australia (22). In both studies, physical inactivity was found to be consistently related to the greatest proportion of dementia cases. This difference can perhaps be partially explained by the results of other published work (17, 23, 24), highlighting the relatively high prevalence rates of hypertension in Barbados compared to the rates of other developed and developing countries (40.7% in Barbados versus 25% in Jamaica and 25% in the United States). In addition, unlike other countries, higher socioeconomic levels have not been shown to be consistently associated with lower hypertension prevalence in the Caribbean (17, 23, 25). This is noteworthy since there has been widespread global interest in the social determinants of health and differences that exist among social groups. Research suggests that while other risk factors for dementia are more consistent with published international patterns, the social distribution of hypertension in the Caribbean area cannot be compared to other parts of the world (17).

Our findings, therefore, have significant implications for the development of dementia risk-reduction programs in Barbados: they suggest that any intervention targeting hypertension, especially midlife hypertension, may result in greater public health gains to the extent that it addresses cognitive health. As governments become hard-pressed to develop interventions to lessen the financial and individual burden of dementia on sufferers and their caregivers, our estimates can provide useful data to determine which risk factors merit the greatest investment.

We also compared our PAR estimates for Barbados with those published for Australia (22) and for Europe, the United Kingdom, and the United States (21). Overall, PAR estimates were highest in Barbados for midlife obesity, diabetes mellitus, and midlife hypertension, and lowest for smoking and physical inactivity. In Barbados, midlife obesity was found to be attributable to 18.3% of dementia cases, high compared to Europe (4.1%), the United Kingdom (6.6%), and the United States (7.3%), and slightly higher than Australia (17.0%). Diabetes mellitus was found to be attributable to 8.0% of dementia cases in Barbados, higher than Australia (2.4%), Europe (3.1%), the United Kingdom (1.9%), and the United States (4.5%). The contribution from midlife hypertension was only available for Australia (13.7%); whereas, in Barbados it was found to be attributable to nearly one-quarter (24.4%) of dementia cases. In contrast, the estimated contribution of smoking to dementia prevalence was lowest in Barbados (2.5%) when compared to Australia 8.7%, Europe (13.6%), the United Kingdom (10.6%), and the United States (10.8%). This may be because, although Barbados has not enacted tobacco control policies, historically, its smoking prevalence has been low. Similarly, for physical inactivity, the proportion of dementia cases attributable to that risk factor was lowest in Barbados (16.3%) compared to the United States (21.0%), the United Kingdom (21.8%), Europe (20.3%), and Australia (17.9%).

A recent report by the Lancet International Commission on Dementia Prevention, Intervention, and Care has also estimated that approximately 33% of global dementia cases may be prevented by targeting modifiable lifestyle factors (26). This new review was conducted using existing data sources. Because data on prevalence of other, established, dementia risk factors (e.g., depression, social isolation, hearing loss) at the population level were not easily available, the present study did not examine their potential con-

tribution; however, the authors of the Lancet report (26) were able to account for these. When population-level risk factor surveillance data for the English-speaking Caribbean becomes available, it will allow for the same valuable comparison.

Our study results suggest that interventions focused on risk reduction have the potential to lessen the future impact of dementia in Barbados. Nonetheless, more complex models are required to determine precisely which interventions will likely make the greatest impact within the unique cultural and socioeconomic context of Barbados. In addition, it is important to account for the longevity paradox—risk reduction leads to increased life expectancy which itself is a risk factor for dementia (27).

There is a paucity of quantitative data on persons living with dementia in the Caribbean. Our study adds considerably to this void, specifically to the literature on dementia and its risk factors in the English-speaking Caribbean. To the authors' knowledge, this is the first study to estimate the proportion of dementia cases attributable to modifiable lifestyle factors in an English-speaking Caribbean country. At present, dementia prevalence data are based on international studies that do not take into account ethnicity and culture (28, 29). This context is important because the prevalence of dementia's known risk factors (diet, physical inactivity, hypertension, and diabetes) are linked to ethnicity, customs, and social behaviors that can result in higher dementia prevalence, particularly among population sub-groups. Another of this study's contributions is that the results can be used to develop targeted interventions with long-term benefits. One example is midlife hypertension, which has no symptoms, but can be identified through screening programs.

**Limitations.** The study limitations include our inability to provide PAR estimates for a wider range of modifiable risk factors and for a greater number of countries. In addition, the method for calculating PAR, assuming non-independence, utilized biased, adjusted relative risk estimates obtained from meta-analyses and its integrity has not been tested. However, this was to be expected given the new method. In addition, until new data are available for the English-speaking Caribbean, studies such as this one are limited to existing datasets such as the SABE. A repeat population-based study would allow for evaluation of whether risk factor prevalence is changing and any implications it may have for the projected prevalence of dementia. Moreover, the effects of risk factor reduction programs depend on the targeted lifecycle stage, and many of our included risk factors focus specifically on midlife. We also acknowledge that we have used a relatively modest method in an attempt to model a complex relationship. Our intention is to account for the effect of more nuanced issues, such as the varying trajectories of individual risk factors, in future work.

## CONCLUSIONS

Over 50% of dementia cases in Barbados were found to be linked to midlife obesity, physical inactivity, smoking, low educational attainment, diabetes mellitus, and midlife hypertension. Dementia risk-reduction programs that target these modifiable lifestyle factors may have the ability to reduce future dementia prevalence in Barbados by more than an estimated one-third by 2050.

While a substantial proportion of dementia cases in Barbados were found to be attributable to the risk factors under study, future research should consider the contribution of other known risk factors, such as Type 2 diabetes, hypertension, and depression. Further studies that take these into consideration could prove useful to policymakers in Barbados and the wider Caribbean.

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**Conflict of interests.** None declared.

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**RESUMEN**

## Proporción de casos de demencia atribuible a factores comunes y modificables relacionados con el modo de vida en Barbados


***Objetivo.*** Establecer el número y la proporción de casos de demencia en Barbados que se pueden atribuir a factores modificables relacionados con el modo de vida y el efecto que podría tener una reducción de estos factores de riesgo en la prevalencia de la demencia en el futuro.

***Métodos.*** Este fue un estudio de observación en el que se usó la fórmula de riesgo atribuible de Levin, que presupone la independencia de los factores de riesgo, para calcular el riesgo de demencia (por cualquier causa) atribuible a la población (RAP) en Barbados en relación con seis factores de riesgo: obesidad en la edad madura, inactividad física, tabaquismo, nivel de escolaridad bajo, diabetes *mellitus* e hipertensión en la edad madura. Se utilizó una fórmula modificada de publicación reciente para incluir los factores de riesgo no independientes, sobre la base de datos secundarios para Barbados. Se computaron el número y la proporción de casos de demencia atribuibles a cada factor de riesgo y a todos los factores de riesgo combinados, al igual que el efecto de una reducción de estos factores de riesgo sobre la prevalencia de la demencia.

***Resultados.*** Teniendo en cuenta el hecho de que los factores de riesgo no operan independientemente, 50,9% de los casos (1 526 casos) se podían atribuir al efecto combinado de los seis factores de riesgo en estudio. Según el análisis, si cada factor de riesgo se redujera de 5% a 20% por decenio, la prevalencia de la demencia podría ser de 3,3% a 31,8% más baja para el 2050.

***Conclusiones.*** Mediante un modelo mayormente teórico, se estimó que 50,9% de los casos de demencia en Barbados eran atribuibles a seis factores modificables relacionados con el modo de vida. Como los factores de riesgo tienen mucho en común, cualquier intervención dirigida específicamente a uno de ellos podría reducir considerablemente la prevalencia de la demencia en el futuro.


**Palabras clave** Prevención & control, demencia; conductas saludables; Barbados.

**RESUMO**

## Proporção de demência atribuível a fatores comuns modificáveis do estilo de vida em Barbados

***Objetivo.*** Conhecer o número e a proporção de casos de demência em Barbados que são atribuíveis a fatores modificáveis do estilo de vida e examinar o efeito que teria uma redução desses fatores de risco na prevalência futura de demência.

***Métodos.*** Estudo observacional realizado com o uso da fórmula do risco atribuível de Levin (pressuposto de independência dos fatores de risco) para calcular o risco atribuível populacional (RAP) da demência (todas as causas) em Barbados para seis fatores de risco: obesidade na meia idade, inatividade física, tabagismo, baixo grau de instrução, diabetes mellitus e hipertensão na meia idade. Uma versão modificada da fórmula recentemente publicada foi usada para representar a não independência dos fatores de risco usando dados secundários do país. O número e a proporção de casos de demência atribuíveis a cada fator de risco e a todos os fatores de risco combinados foram computados, assim como o efeito de uma redução desses fatores de risco na prevalência futura de demência.

***Resultados.*** Considerando que os fatores do risco não atuam de modo independente, 50,9% (1.526 casos) foram atribuíveis ao efeito combinado dos seis fatores de risco estudados. De acordo com a análise, se cada fator de risco tivesse uma redução de 5%–20% por década, a prevalência da demência poderia cair de 3,3% a 31,8% até 2050.

***Conclusões.*** De acordo com um modelo eminentemente teórico, estimou-se que os seis fatores modificáveis do estilo de vida eram atribuíveis a 50,9% dos casos de demência em Barbados. Visto que os fatores de risco têm muito em comum, qualquer intervenção que vise um dos fatores poderia reduzir consideravelmente a prevalência futura da demência.

**Palavras-chave** Prevenção & controle, demência; comportamentos saudáveis; Barbados.