

RESEARCH

Population-wide weight loss and regain in relation to diabetes burden and cardiovascular mortality in Cuba 1980-2010: repeated cross sectional surveys and ecological comparison of secular trends

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Abstract

Objective To evaluate the associations between population-wide loss and gain in weight with diabetes prevalence, incidence, and mortality, as well as cardiovascular and cancer mortality trends, in Cuba over a 30 year interval.

Design Repeated cross sectional surveys and ecological comparison of secular trends.

Setting Cuba and the province of Cienfuegos, from 1980 to 2010.

Participants Measurements in Cienfuegos included a representative sample of 1657, 1351, 1667, and 1492 adults in 1991, 1995, 2001, and 2010, respectively. National surveys included a representative sample of 14 304, 22 851, and 8031 participants in 1995, 2001, and 2010, respectively.

Main outcome measures Changes in smoking, daily energy intake, physical activity, and body weight were tracked from 1980 to 2010 using national and regional surveys. Data for diabetes prevalence and incidence were obtained from national population based registries. Mortality trends were modelled using national vital statistics.

Results Rapid declines in diabetes and heart disease accompanied an average population-wide loss of 5.5 kg in weight, driven by an economic crisis in the mid-1990s. A rebound in population weight followed in 1995

(33.5% prevalence of overweight and obesity) and exceeded pre-crisis levels by 2010 (52.9% prevalence). The population-wide increase in weight was immediately followed by a 116% increase in diabetes prevalence and 140% increase in diabetes incidence. Six years into the weight rebound phase, diabetes mortality increased by 49% (from 9.3 deaths per 10 000 people in 2002 to 13.9 deaths per 10 000 people in 2010). A deceleration in the rate of decline in mortality from coronary heart disease was also observed.

Conclusions In relation to the Cuban experience in 1980-2010, there is an association at the population level between weight reduction and death from diabetes and cardiovascular disease; the opposite effect on the diabetes and cardiovascular burden was seen on population-wide weight gain.

Introduction

It was recognised early in the course of the global epidemic of type 2 diabetes that variation in the prevalence of the disease among populations could be explained largely by relative weight.¹ This observation is supported by survey research from virtually every country in the World Health Organization database.² Despite predictions on the effect of the obesity and diabetes epidemics on life expectancy,³ it is unclear to what

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Web appendices: Supplementary material

extent they can alter the downward trend of cardiovascular diseases prevalence observed in many countries.⁴ Furthermore, lack of adequate data for public health precludes the empirical assessment of comparable trends across the developing world. Most cohort studies have suggested a “U” shaped association between body mass index and mortality, with the lowest point in the index range of 24 to 29.^{5,6} Therefore, key unknown factors are the net health impact of a given downward shift in the distribution of body mass index in a population, and the time lag between changes in body mass index and in the prevalence of non-communicable disease.⁷

Marked and rapid reductions in mortality from diabetes and coronary heart disease were observed in Cuba after the profound economic crisis of the early 1990s.⁸ These trends were associated with the declining capacity of the Cuban economy to assure food and mass transportation in the aftermath of the dissolution of the former Soviet Union and the tightening of the US embargo. Severe shortages of food and gas resulted in a widespread decline in dietary energy intake and increase in energy expenditure (mainly through walking and cycling as alternatives to mechanised transportation).

The largest effect of this economic crisis occurred over a period of about five years (1991–95, the so called “special period”), resulting in an average weight loss of 4–5 kg across the adult population.⁸ This economic crisis was not a full disruption of previous routines of daily life, but was actually characterised by its slow process of economic decline. During these years, the whole population continued to meet responsibilities in relation to work, school, and other social aspects, and the Ministry of Public Health maintained its regular surveillance system activities.^{9,10}

Since then, the Cuban economy has shown a modest but constant recovery, especially after the year 2000.^{11,12} In fact, surveys have shown that the prevalence of obesity has now exceeded pre-crisis levels.¹³ The table¹ shows basic sociodemographic and economic information on Cuba before, during, and after the economic crisis.

To advance the prevention of non-communicable diseases, population-wide data remain crucial. Comparing disease rates over time, in relation to changes in risk factor levels in the population, indicates the extent to which disease can be prevented and what the most important risk factors are at the population level.¹⁴ The population preventive approach articulated by Geoffrey Rose in his seminal paper,¹⁵ is of importance when preventing and controlling non-communicable diseases, particularly cardiovascular diseases. The current study exemplifies a unique situation where population-wide body weight changed considerably, as a result of the combined and sustained effect of reduced energy intake and elevated physical activity. This scenario allowed us to assess its effect on diabetes and cardiovascular disease.¹⁶

Our objective was to examine the effect of population-wide changes in body weight—over a full cycle of weight loss and regain—on diabetes incidence, prevalence, and mortality in Cuba, from 1980 to 2010. We also assessed the effects of this weight change cycle on rates of death from cardiovascular disease, cancer, all causes.

Methods

To study the population-wide changes in body weight over time, we used four cross sectional surveys in the city of Cienfuegos, on the southern coast of Cuba. These surveys are part of the Project of Cienfuegos, an initiative designed to study the risk factors for non-communicable diseases in Cuba.

To obtain all available data from government and published sources on mortality, physical activity, energy intake, and smoking in Cuba between 1980 and 2011, we did a systematic search. We used the following databases: Medline, Spanish Bibliographic Index in Health Sciences (IBECS), and the Scientific Library Online (BVS-SciELO Cuba), which includes most Cuban journals. Web appendix 1 details the 12 references included.

Height, weight or overweight, and obesity

The four cross sectional surveys measured height and weight, on the basis of stratified probability samples from the urban population aged 15–74 years. The surveys included 1657, 1351, 1667, and 1492 adults for the years 1991, 1995, 2001, and 2011, respectively. The age distribution of the population in Cienfuegos is similar to the general Cuban population (web appendix 2). We used the following categories for body mass index: underweight (<18.5), normal weight (18.5–<25), overweight (25–<30), and obesity (≥30). All participants in the four surveys signed the informed consent. The ethics committee of the University of Medical Sciences, Cienfuegos, approved protocols.

Physical activity

Measures of self reported physical activity were available from representative samples of the population in Havana in 1987, 1988, and 1994 and from the national surveys on risk factors and chronic diseases (conducted nationally in 1995, 2001, and 2010, respectively). In these surveys, participants were designated as physically active if they engaged in regular physical activity, defined as 30 minutes of moderate or intense activity on at least five days per week.

Energy intake

The Food and Agriculture Organization of the United Nations provides disappearance data on energy intake per capita, by dividing total calories available for human consumption by the total population consuming the food supply during the reference period.

Smoking

National use of cigarettes per capita was calculated as the total number of cigarettes sold per year divided by the population aged 15 years and over. The prevalence of smoking was obtained from the national surveys on risk factors and chronic diseases conducted in 1995, 2001, and 2010, and other national studies previously conducted. We defined smoking as self reported current use of cigarettes or cigars (or both).¹⁷

Diabetes prevalence and incidence

In the Cuban national health system, the primary care doctor-nurse team is responsible for collecting health data for all residents in the neighbourhood of their catchment area (about 1500 individuals per team). One of the team activities organised by the health system is continuous assessment and risk evaluation (CARE, or Dispensarización in Spanish).^{18,19} All households are visited at least once a year for a comprehensive health evaluation of the family, while patients with chronic diseases receive a visit at least once every three to six months. These health examinations covered 61.2% (n=595 1088) of the population in 1979,²⁰ 75.9% (n=7 918 647) in 1989,²⁰ and 98.2% (n=11 038 820) in 2009.²¹ We obtained data for diabetes prevalence and incidence from the CARE registries, spanning

the time period of 1980-2009.^{20 21} These registries allow the monitoring of chronic disease trends, such as diabetes incidence or prevalence.

Mortality

We obtained annual, age adjusted rates of mortality per 100 000 people from the Cuban Ministry of Public Health. ICD-10 (international classification of diseases, 10th revision) codes were used for death from type 2 diabetes (E10-E14), coronary heart disease (I20-I25), stroke (I60-I69), cancer (C00-C97), and all causes for the period of 1980-2010. We used data from 1980 to examine possible trends unrelated to the economic crisis during the special period in 1991-95. The 1981 Cuban population census was used for age adjustment. Vital records in Cuba are essentially complete. Postmortem examinations in some hospitals include up to 85% of people coded as dying from cardiovascular disease, which provided considerable confidence in an accurate designation of the cause of death.²²

Statistical analysis

To illustrate the distributions of body mass index in the four surveys from Cienfuegos (in 1991, 1995, 2001, and 2011), we used Stata SE version 12.1 to generate density plots through the Gaussian kernel function. To analyse changes in prevalence and mortality, joinpoint regression analysis was conducted using software developed by the Surveillance Research Program of the United States National Cancer Institute.²³ This regression model allows identification of significant changes in linear trend slopes. The estimated annual change (%) was then computed for each mortality trend by fitting a regression line to the natural logarithm of the rates within each period or phase.

We did not use this procedure to analyse diabetes incidence, owing to missing data from the years during the crisis. Because incidence estimates are inherently unstable, we enhanced visual presentation by constructing moving averages for each year with available data, using the incidence data from the previous, current, and following year.

Results

Risk factor trends

From its lowest point in the mid-1990s, average daily intake of energy per capita increased monotonically, reaching pre-crisis levels in 2002 and levelling off in 2005 (fig 1). On the other hand, physical activity had a slight downward trend after the mid-1990s, remaining stable from 2001, with more than half of the population being physically active. Although 80% of the population was classified as active in surveys conducted during the special period in 1991-95, this proportion fell steadily in the last decade, and is currently at 55% (fig 1). These population-wide changes in energy intake and physical activity were accompanied by large changes in body weight over this entire interval (figs 2 and 3).

Smoking prevalence (fig 1) slowly decreased during the 1980s and 1990s (42% in 1984, 37% in 1995), before declining more rapidly in the 2000s (32% in 2001, 24% in 2010). The number of cigarettes consumed per capita decreased during and shortly after the crisis. In 1990, 1934 cigarettes per capita were consumed (fig 1). This number changed to 1572, 1196, and 1449 cigarettes per capita in 1993, 1997, and 1999, respectively. Cigarette consumption has since remained stable.

Figure 2 depicts the distribution of body mass index from the Cienfuegos surveys of 1991, 1995, 2001, and 2010 with kernel density plots of each year's measurements. During the special

period of 1991-95, there was a weight loss of 5.5 kg across the entire range of body mass index (that is, not only among obese people), with a mean reduction in body mass index of 1.5 units. After a period of economic recovery and stability, an increase in body mass index of 2.6 units was observed from 1995 to 2010; weight regain also occurred across the entire population, irrespective of body mass index. These distribution shifts in body mass index were consistent across surveys. The proportion of the population in the normal weight category decreased from 56.4% at the end of the special period in 1995 to 42.1% in 2010. At the same time, proportions in the overweight and obesity categories increased by 19.4%, from 33.5% in 1995 to 52.9% in 2010 (web appendix 3).

Diabetes trends

Diabetes prevalence and incidence

Joinpoint regression analyses showed two different phases of diabetes prevalence (fig 3). The first phase had a slow and stable increase from 1980 (1.5 per 100 people) to 1997 (1.9 per 100 people), a total increase of 26.6% (2.9% per year). In the second phase, diabetes prevalence increased from 1.9 per 100 people in 1997 to 4.1 per 100 people in 2009 and 2010, a total increase of 115.8% (6.3% per year).

Incidence of diabetes fluctuated widely (fig 3). For the decade before the crisis, incidence was stable, between 1980 (1.5 per 1000 people) and 1989 (1.8 per 1000 people). The only data point in the middle of the economic crisis showed a decrease in diabetes incidence, falling to 1.2 per 1000 people in 1992. For the years immediately after the crisis, incidence was lower than pre-crisis levels (1 per 1000 people in 1996 and 1997 v 1.4 per 1000 people in 1999). Sharp increases were observed from 2000 onwards, peaking in 2002 (2.2 per 1000 people) and 2009 (2.4 per 1000 people). Thus, overall diabetes incidence decreased by 53% from its peak in the pre-crisis years (1986) to its lowest point after the crisis (1996 and 1997). Subsequently, incidence rose by 140% from 1996 to 2009.

Diabetes mortality

Joinpoint regression analysis of diabetes mortality showed four different phases (fig 3). The first phase, from 1980 to 1989 (pre-crisis years), was characterised by an increase of 60% (5.9% per year). The second phase from 1990 to 1996 overlapped with the special period in 1991-95, during which diabetes mortality stabilised (0.7% decrease per year). However, from 1996 to 2002, we recorded a decrease in diabetes mortality of 50% (13.95% per year). Finally, from 2002 onwards, mortality rose by 49% (3.31% per year; from 9.3 deaths per 10 000 people in 2002 to 13.9 deaths per 10 000 people in 2010), returning to pre-crisis rates.

Mortality trends

Coronary disease mortality

Mortality from coronary heart disease evolved in three phases (fig 4). From 1980 to 1996, mortality fell consistently (reduction of 8.8%, 0.5% per year). After the crisis in 1996-2002, mortality decreased sharply by 34.4% (6.5% per year). After 2002, the rate of decline slowed to 7.4% (1.4% per year), similar to pre-crisis rates.

Stroke mortality

Mortality from stroke mirrored the pattern of mortality from coronary heart disease, with a modest decrease of 6.9% lasting from 1980 to 2000 (0.4% per year) and a sharp fall between

2000 and 2004 of 13.6% (5.3% per year). From 2004 to 2010, mortality fell by 1.3% (0.01% per year, similar to pre-crisis rates).

Cancer mortality

Cancer mortality followed a distinctly different pattern to that observed in coronary heart disease, stroke, and diabetes, with two distinct phases (fig 4). From 1980 to 1996, a slight decrease of 2.4% in cancer mortality was observed (0.1% per year), which reverted to a slight increase of 5.4% in 1996-2010 (0.5% per year).

All cause mortality

Mortality from all causes, as expected, was highly influenced by trends in coronary heart disease and stroke, showing three different phases (data not shown). A prolonged decrease in mortality of 1.7% from 1980 to 1996 (0.1% per year) was followed a sharp decline of 10.5% from 1996 to 2002 (2.9% per year). From 2002 to 2010, there has been a modest decrease of 2% (0.7% per year).

Discussion

During the deepest period of the economic crisis in Cuba, lasting from 1991 to 1995, food was scarce and access to gas was greatly reduced, virtually eliminating motorised transport and causing the industrial and agricultural sectors to shift to manual intensive labour. This combination of food shortages and unavoidable increases in physical activity put the entire population in a negative energy balance, resulting in a population-wide weight loss of 4-5 kg.⁸ The decline in food availability was associated with a neuropathy outbreak in the adult population in 1993.²⁴⁻²⁵ The Cuban economy started recovering in 1996 with a sustained growth phase from 2000 onwards. Since 1996, physical activity has slightly declined. By 2002, energy intake had increased above pre-crisis levels.

As a result of the above trends, by 2011, the Cuban population has regained enough weight to almost triple the obesity rates of 1995. This U shaped, population-wide pattern in body weight is historically unique because of several factors: the initial weight loss occurred in a population that had been well nourished previously, lasted for five years, and affected people at all initial levels of body mass index.

Diabetes trends could have been substantially influenced by these population-wide changes in body weight. Diabetes prevalence surged from 1997 onwards, as weight started to rebound. Diabetes incidence decreased during the crisis, reaching its lowest point in 1996. The largest economic recovery saw diabetes incidence peaking in 2004 and 2009.

Five years after the start of the economic crisis in 1996, an abrupt downward trend was observed in mortality from diabetes, coronary heart disease, stroke, and all causes. This period lasted an additional six years, during which energy intake status gradually recovered and physical activity levels were progressively reduced; in 2002, mortality rates returned to the pre-crisis pattern. A particularly dramatic shift in diabetes mortality was observed: from 2002 to 2010, the annual increase in diabetes mortality was similar to that before the crisis. Moreover, declining rates of coronary heart disease and stroke slowed to annual decreasing rates similar to those before the crisis.

Comparison with other studies

The effect of high risk, preventive approaches on diabetes or cardiovascular mortality has been extensively studied and has reported conflicting and non-conclusive results. For example, the Look AHEAD clinical trial,²⁶ aimed at reducing cardiovascular risk associated with diabetes through weight reduction and exercise, has been prematurely terminated for lack of an effect on cardiovascular mortality. Other high risk approaches, such as the prevention and control of diabetes through massive screenings, has recently shown no improvements in diabetes, cardiovascular, or all cause mortality.²⁷ Overall, it seems that high risk preventive approaches have either not produced a beneficial effect on cardiovascular mortality or diabetes control and mortality, or have been unsuccessful in reducing risk to a sufficient degree to warrant a conclusion.

The complementary pathway to disease prevention, the population approach, has received scant attention in the literature. To our knowledge, the effect of population-wide weight regain on diabetes and cardiovascular mortality has not been previously studied. Research on population-wide interventions has so far only studied modelling studies²⁸ or small scale interventions.¹⁴

Research on weight cycling, described in obese individuals undergoing repeated attempts at weight loss followed by weight regain, has reported conflicting results: either an increase²⁹⁻³² or no association with general mortality.³³ Specifically, no association between weight cycling and diabetes incidence has been recorded.³⁴⁻³⁵ Since individual weight cycling usually refers to multiple weight changes over an extended period, those results might have limited relevance for the population experience of a single cycle of weight gain, loss, and regain that we report here.

As shown in our results, smoking levels were affected by the crisis. The number of cigarettes smoked per capita in Cuba decreased in the crisis years, only to slightly recover afterwards and remain stable thereafter. Smoking prevalence has continuously decreased during the past 15 years in Cuba. The role of tobacco in the development and control of diabetes has been recently studied; both active and passive smoking are associated with increased incidence.³⁶ This association is dose dependent³⁷; therefore, the decrease in smoking in Cuba during the crisis may have contributed to the decline in diabetes incidence in those years. The effects of decreasing smoking rates should drive down the rates of diabetes incidence and mortality in the long term. In this case, the observed decline in smoking rates during and after the crisis should cause a decrease in diabetes mortality in the last decade of our study. The increase in diabetes mortality from year 2002 seems to rule out smoking as a major confounding factor in the observed trends, although it could be masking the true size of the effect of changes in dietary and physical activity on diabetes mortality. This consideration is analogous for coronary heart disease and stroke, which should fall as smoking prevalence declines.

Strengths and limitations of study

Our study presents the first observation of a population-wide event of this magnitude and its subsequent effects on public health. Population-wide shifts in other risk factors, such as cholesterol and blood pressure, have been described in large scale prevention interventions, for example, the North Karelia and FINRISK studies.³⁸ In the Cuban experience, the changes in population-wide body weight were adaptive responses to dietary energy availability and energy expenditure; therefore,

it is not possible to separate these two effects on mortality patterns.

Other unique effects of this experience should also be considered. Problems with food production in Cuba led to the creation and expansion of urban agriculture, allowing citizens to buy fresh produce directly from farmers. Large public health campaigns in schools and communities are currently in place using community gardening as an effort to improve nutrition education and diet quality.³⁹ During the crisis, the Cuban government acquired and distributed more than one million bicycles, which contributed to the population-wide increase in physical activity.³⁹ These unique features of the Cuban experience make it to that degree non-comparable with other examples of economic crises. For example, previous research on the health consequences of the Great Depression in the US showed that banking suspensions (as a proxy for large scale economic decline) was not followed by a decrease in mortality.⁴⁰

As noted previously, controversy persists over the net benefit of generalised weight loss in modern populations.⁴¹ As articulated by Geoffrey Rose,¹⁵ a key element of a prevention strategy for diseases in populations with near universal exposure to the causal risk factor is a downward shift in the overall mean. The data presented here confirm this theory. The Cuban experience shows that within a relatively short period, modest weight loss in the whole population can have a profound effect on the overall burden of diabetes. In Cuba, weight loss also had a major effect on trends in cardiovascular diseases and all cause mortality. Although obesity is an important risk factor for cancer,⁴² only modest changes in cancer mortality were observed.

Our study has some important limitations. We had no data on diabetes incidence for most crisis years, and rates in the subsequent years showed wide fluctuations. Data for diabetes mortality were available for the whole study period, but might not have adequately represented the health burden of diabetes. Death certificates are subject to misclassification bias, although the parallel trends in cardiovascular and all cause mortality rule out substantial shifts away from diabetes to major illnesses that occurred at the same time—the most common of which would have been vascular in cause. The cyclic pattern of the observed trends makes a bias less likely, owing to widespread changes in coding of death certificates. Estimating dietary intake from food disappearance data has known limitations, but data from available dietary surveys for the years before, during, and after the special period were consistent with food disappearance data from the Food and Agriculture Organization.⁸

Conclusions and policy implications

We found that a population-wide loss of 4-5 kg in weight in a relatively healthy population was accompanied by diabetes mortality falling by half and mortality from coronary heart disease falling by a third. Furthermore, a rebound in body weight was associated with an increased diabetes incidence and mortality, and a deceleration of the decline in mortality from coronary heart disease. So far, no country or regional population has successfully reduced the distribution of body mass index or reduced the prevalence of obesity through public health campaigns or targeted treatment programmes.¹⁶ The latest reports in the US have documented a plateau in the epidemic curve of obesity in adults,⁴³ children, and adolescents,⁴⁴ but the public health effects of these changes have not yet been reported. It is therefore not possible to compare the Cuba findings with other populations. Therefore, the generalisability of our findings is uncertain. Nonetheless, these data are a notable illustration of

the potential health benefits of reversing the global obesity epidemic.

We would like to acknowledge our great respect and admiration for the Cuban people who faced extremely difficult social and economic challenges during the special period—and by making common cause against this tragedy held up with courage and dignity. This tragedy was “man made” by international politics and should never happen again to any population.

Contributors: MF and RC contributed to the original design. PO, MB, and AM organised and conducted data collection. UB conducted the statistical analyses. MF, UB, and RC carried on the systematic literature research. MF, UB, PO, BC, JFK, and RC were active in the interpretation of results. The manuscript was drafted by MF, UB, JFK, and RC, and reviewed by all authors. All authors have approved the final report. All authors had full access to the data in the study and take responsibility for its integrity and the accuracy of the data analysis. MF is the guarantor for this study.

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What is already known on this topic

The health effects of population-wide changes in body weight on a well nourished population with a functioning universal health system is unknown

Large reductions in diabetes and cardiovascular mortality were noted after the population-wide weight loss in Cuba, during the economic crisis of the early 1990s

What this study adds

Body weight regain in the Cuban population was associated with an increase in diabetes prevalence, incidence, and mortality, as well as a deceleration in the previously declining rates of cardiovascular death

Small losses in body weight and prevention of body weight gain across the population could be a critical strategy in the prevention of non-communicable diseases

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Table

Table 1| Basic sociodemographic and economic information on Cuba at various stages of economic crisis¹²

	1980-90*	1991-95†	1996-99‡	2000-10§
Total population (no of people)	10 129 295	10 784 106	11 029 124	11 233 417
Total area (km ²)	110 860			
Yearly GDP growth (%)	+3.44	−6.79	+4.58	+5.23
Gross national income per capita (purchasing power parity; \$)	3200	2397	2491	3597
Dietary energy consumption per capita (MJ)¶	12.66	10.27	11.41	13.56
Adult literacy rate (%)	97	99	99.8	99.8
Mean life expectancy (years)	74.2	74.8	75.9	77.8

\$1=£0.66; €0.77.

*Before economic crisis.

†Special period.

‡Late economic crisis/early economic recovery.

§Economic recovery.

¶1 kcal=0.00418 MJ.

Figures

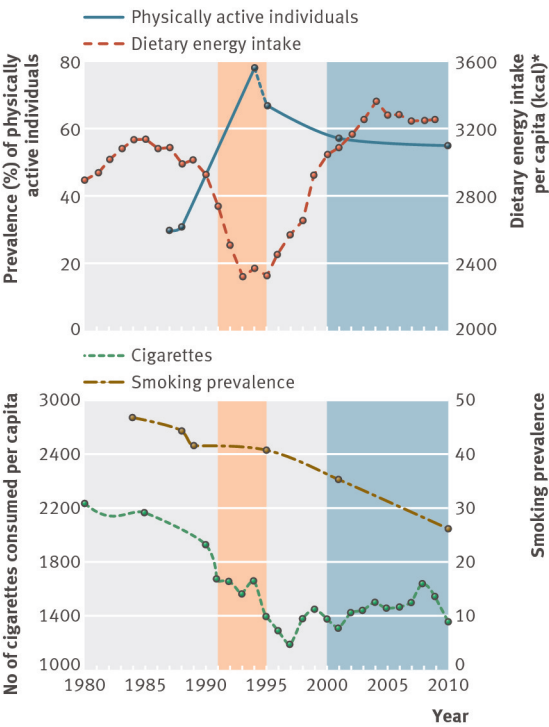


Fig 1 Physical activity, dietary energy intake, and smoking in Cuba, 1980-2010. Red shaded area=period of economic crisis; blue shaded area=period of economic recovery. Physical activity data recorded in 1987, 1988, and 1994 obtained from Havana surveys; data recorded in 1995, 2001, and 2010 come from national surveys. *1 kcal=0.00418 MJ

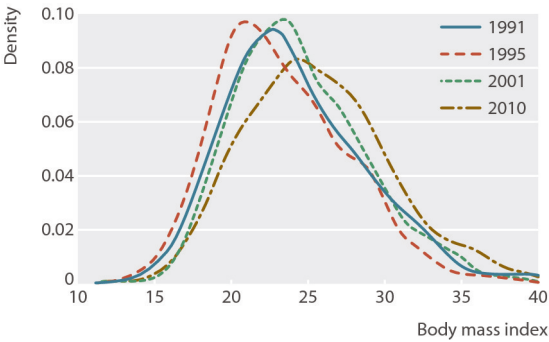


Fig 2 Distributions of body mass index as recorded by national surveys conducted in Cienfuegos in 1991, 1995, 2001, and 2010

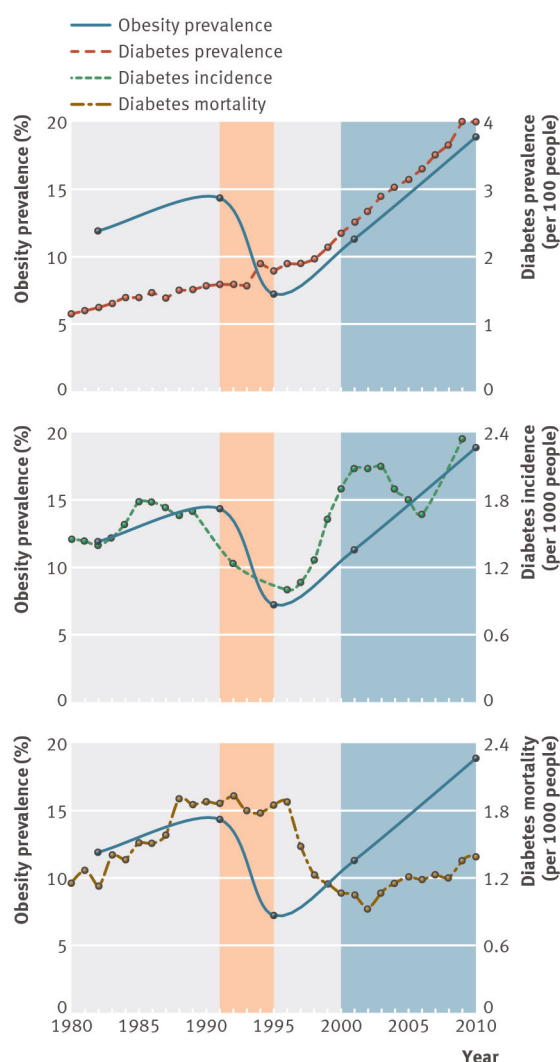


Fig 3 Prevalence of obesity and diabetes, incidence, and mortality in Cuba, 1980-2010. Red shaded area=period of economic crisis; blue shaded area=period of economic recovery. Diabetes prevalence increased by 2.93% per year from 1980 to 1997, and 6.27% per year from 1997 to 2010. Diabetes mortality increased by 5.85% per year from 1980 to 1989, but fell by 0.68% per year from 1989 to 1996 and 13.95% per year from 1996 to 2002, before increasing by 3.31% per year from 2002 to 2010

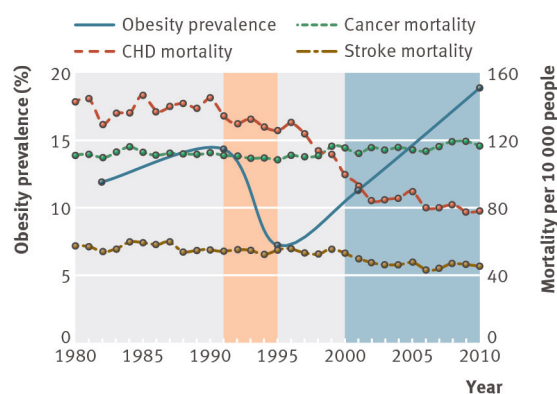


Fig 4 Obesity prevalence and coronary heart disease, cancer and stroke mortality in Cuba (1980-2010). Red shaded area=period of economic crisis; blue shaded area=period of economic recovery; CHD=coronary heart disease. CHD mortality decreased by 0.50% per year from 1980 to 1996, 6.48% per year from 1996 to 2002, and 1.42% per year from 2002 to 2010. Cancer mortality decreased by 0.12% per year from 1980 to 1996, but increased by 0.47% per year from 1996 to 2010. Stroke mortality fell by 0.39% per year from 1980 to 2000, 5.03% per year from 2000 to 2004, and 0.01% per year from 2004 to 2010