

An Assessment of Health-Economic Burden of Obesity Trends with Population-Based Preventive Strategies in a Developed Economy

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ABSTRACT

The burden of obesity varies with age, ethnicity, socio-economic status and state economies. All new projections should hence accommodate population ageing, and other population changes such as immigration, health-care system reform, or technological advances for disease treatment for a comprehensible assessment of global burden. The unaffordable and expensive nature for reversing the obesity tide arises from policies developed to combat obesity. Most of these approaches aim at bringing the problem under control, rather than affecting a cure, and obviously require a multi-disciplinary and intensive regimen. Prevention is the only feasible option and is essential for all affected countries. Yet it is not simple to have population based UK-wide strategic framework for tackling obesity. Besides existence of multiple layers of governance, there are clear demarcations between targets in diet; nutrition and physical activity level between regions some of which are not realistic. Population based approaches target policies and process, aiming for a transition towards healthy population diets, activity levels and weight status. It is essential to understand these aspects differ culturally and between and within countries. There are still no clear and appropriate answers about answer when, where, why, and, how costs accrue in obese populations, further long term commitments are required for the same. Most population-based prevention policies are cost effective, largely paying for themselves through future health gains and resulting reductions in health expenditures. Therefore these prevention programs should be high on the scientific and political agendas.

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1. INTRODUCTION

During the past few decades, the prevalence of obesity has grown to epidemic proportions, and this condition is now known to be a major contributor to the global burden of disease [1]. Obesity is defined as a chronic disease characterised by an increase of body fat stores or an ‘abnormal or excessive fat accumulation that may impair health’ [2]. In clinical practice, the body fatness is assessed by the Body Mass Index (BMI) which is a derived ‘marker of obesity’ and is measured in kg/m².

$$\text{BMI} = \frac{\text{Measured body weight (kg)}}{\text{Measured height (m}^2\text{)}}$$

In adults, WHO defines obesity by a BMI ≥ 30 and overweight (also termed pre-obesity) by a BMI 25–29.9 in Caucasians. Individuals found in overweight range of BMI 25–29.9 chronically, have higher odds of becoming obese in later life [3]. Cross-cultural paradigms arose in adiposity assessment when several studies reported at the same BMI level, higher body fat percentage is found in Asians than in Caucasians yet their prevalence of obesity is much lower [4]-[6]. This implied that at a certain BMI level, body fatness and fat distribution might vary across populations prompting IDF (International Diabetes Federation) and the IOTF (International Obesity Task Force) to introduce different BMI cut points for other ethnicities. Complications persisted in defining overweight and obesity among children as dynamics in change of height and weight are mostly uncertain. BMI therefore became a less reliable predictor of obesity among children before an international standard was proposed for childhood obesity using different methodologies [7].

In the last decade, BMI has been publicised as an imprecise obesity marker, as individuals with the same BMI were found to have different levels of body fat content. Recent studies indicate that abdominal obesity or visceral adiposity is significantly associated with metabolic and cardiovascular diseases and suggests that waist circumference is more closely associated with mortality and morbidity than BMI [8].

1.1. Pathogenesis of obesity

Obesity develops as a result of a period of chronic energy imbalance [9] and is maintained if these elevated levels of increased energy intake persist. Globalization has made the world wealthier. The consequent transition in economies has contributed to shifting dietary patterns, for example, higher per capita energy availability with increased consumption of energy-dense diets high in fat (fast-food), larger portion sizes, food consumed outside the home, greater consumption of soft drinks, and [10]-[12]. This compounded with decline in energy expenditure (sedentary lifestyle-motorized transport, labour-saving devices at home, the phasing out of physically demanding manual tasks) has led to development of obesity. Genetics account for 60–85% of the variation in obesity but if genes ‘load the gun’ the obesity-promoting environment ‘pulls the trigger’, therefore interaction between biological factors, behavioural and environmental factors together regulate energy balance and fat stores [9],[13]. UK Foresight Programme (2007) introduced the Obesity System Map to model determinants of obesity, reproducing comprehensive, complex results along similar lines [14]. Migration of populations may also account for a proportion of the epidemic.

1.2. Consequences of obesity

Obesity has a more pronounced impact on morbidity than mortality and severely impairs quality of life. Obesity is known to exist with its chronic co-morbidities as shown in Figure 1 like cardiovascular disease, type 2 diabetes mellitus, respiratory disorders, cancer, osteoarthritis, work disability, and sleep apnoea [1]. These together have been responsible for 38% of all-cause mortality, 31% of years of life lost in early deaths, 12% of years of life lost in disability and 21% of DALYs disability adjusted life years in WHO EUR-A region where 7.3% of all DALYs lost were directly attributable to overweight and obesity. The World Health Report reported that obesity is responsible for between 8% and 15% of disability adjusted life years (DALYs) lost in Europe and North America [15]. Disabling effect of obesity comes through arteriosclerosis or triopathy of diabetes-nephropathy, neuropathy, and retinopathy when insulin is not sufficient [16]. As the obesity epidemic spreads, concern about the significant health and economic consequences has also grown.

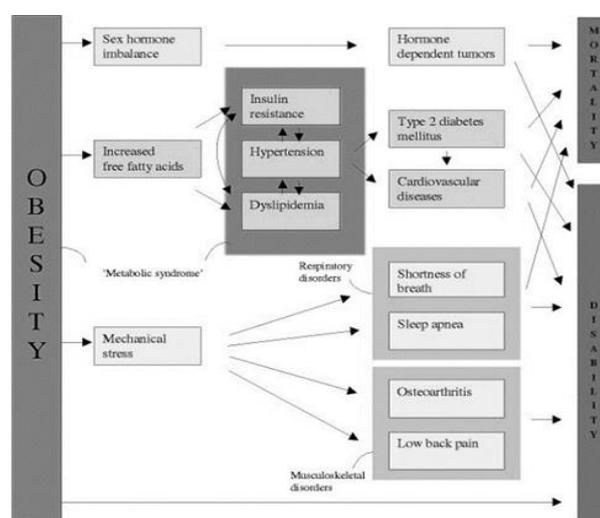


Figure 1. The Public Health Impact of Obesity, Adapted [1]

The present review is not a standard systematic review but an attempt to find appropriate answers associated with need based assessment about when, where, why, and, how burdens accrued in obese populations of a developed economy like UK, and an overview linked the further long term commitments required.

2. RESEARCH METHOD

We searched articles indexed in MEDLINE and published in English 1995 and June 2014 to identify data on burdens associated with obesity in a developed economy of UK. The Medical Subject Heading (MeSH) terms “obesity” and “obesity, morbid” were combined with those for “costs and cost analysis,” “economics, pharmaceutical,” “economics, medical,” “economics, hospital,” and “work disability.” The MEDLINE search returned 32 results, and 24 articles were selected for full-text review. EMBASE, International Pharmaceutical Abstracts (IPA), and Current Contents Connect (CCC) databases also were searched with similar keywords and limits; 12 additional unique articles were located, and 4 were chosen for full-text review. In addition, supplemental searches of data published on the Internet by the World Health Organization (WHO) and governmental agencies were conducted, and seven sources were selected for further consideration. For all search results, costs related to behavioral or lifestyle interventions for obesity were excluded. Of the all costrelated full-text documents reviewed, 14 studies or reports presented national or regional data in one or more regions of interest, and information from these sources is presented here. The cost data are summarized and grouped by study methodology and adapted from other studies for comparative overview. Converting all health care costs to a uniform, price-adjusted currency allows comparison of the volume of health care purchased in the different countries (without adjusting for population size differences among the countries).

3. RESULTS AND ANALYSIS

3.1. Sizing the problem: epidemiological overview

A compilation of epidemiological studies from 199 countries revealed that 1.46 adults worldwide were estimated to be overweight in 2008, and of these 502 million were obese, through systemic analysis [17]. UK is also experiencing an epidemic of overweight and obesity. The prevalence of excess weight is increasing rapidly across the country, and in 2013 close to 62% of the adult population was found to be overweight or obese [18]. A comparative trend by HSE (Health Survey for England) data documented, the prevalence of severe obesity among women increased from 1.4% in 1993 to 3.1% in 2012 and among men prevalence increased from 0.2% in 1993 to 1.7% in 2012, and is predicted to reach around 70% by 2034. The numbers are overwhelming and are second only to the USA as shown in Figure 2. Across borders, 20% of all adults in most European countries are already obese and with higher rates often found in the Southern, Central and Eastern European nation [19]. While Middle East encounters exceptionally high obesity levels and type 2 diabetes [20], Caribbean Islands are struggling with overwhelming medical burden of premature diabetes and cardiovascular disease [21]. Asian and African countries have been hit by dual burden of diseases with soaring prevalence rates of obesity and its associated type 2 diabetes [22] elucidated by the nutrition-transition paradox [23]. Obesity in UK tends to increase with age (up to 64 years) and is more common in people with low educational attainment, low income or in manual occupations. Ethnic differences are apparent underpinning later health inequalities across Great Britain [24],[25].

A conundrum was created due to unusual genetic-environmental problems associated with obesity and differential cut-offs for BMI (which changes by age and differentially by sex) when childhood obesity trends were to be assessed. Once solved, serial increasing trends in obesity prevalence were documented in most Western countries, especially the UK and the USA. HSE figures show that the average prevalence of overweight and obesity in children aged 2-10 and 11-15 years is around 26% and 35% respectively [26]. 10% of the world's school-aged children are estimated to be carrying excess body fat, quarter of which are known to have significant likelihood of some other multiple risk factors and co-morbidities before or during early adulthood. It has been reported that nearly 0.5-1% of all children are becoming overweight each year in USA, Brazil, Canada, Australia and parts of Europe [13].

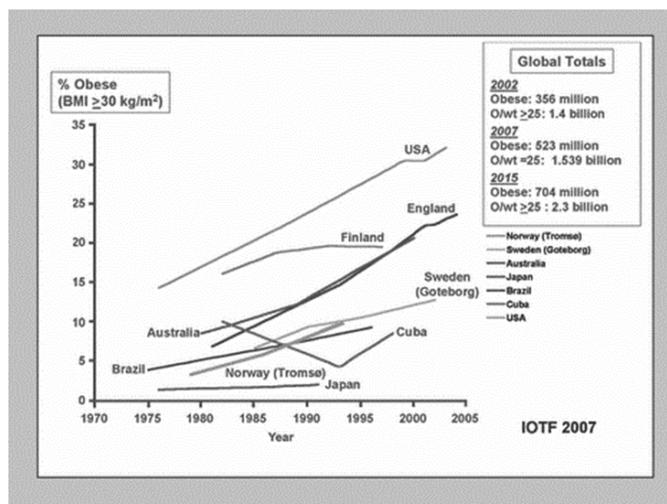


Figure 2. Analyses of the Escalating Obesity Rates in Different Countries; Adapted [19]

3.2. Obesity as Public Health burden

As the obesity epidemic is subjected to diverse economic and cultural landscape, so are its consequences therefore, the impact of obesity is measured as combined effect on disability and mortality as seen in Figure 2. The disabling effect of obesity or morbidity has been the focus of recent studies as population longevity has increased and it directly impacts quality of life and physical, social, and mental functioning [27],[28]. This includes osteoarthritis especially in elderly [29], infertility [30] and respiratory disorders like asthma [31].

Though studies have reaffirmed the association of high BMI levels as risk factors for all-cause mortality especially premature mortality [32] but odds were found to be higher for disease incidence, i.e., for type 2 diabetes mellitus, myocardial infarction, and ischemic stroke [1],[33] and at older ages [34]. These trends were attributed to increased cholesterol levels. The WCRF panel estimated that 30% - 40% of all cancers are attributable to inappropriate diet, lack of physical activity, and high body weight [35]. The health burden from obesity is largely equated to benign prostate hypertrophy [36] and several other forms of cancer due to metabolic abnormalities occurring at high BMI levels. It has been reported that for males, risk for esophageal cancer increases by 52% and for colon cancer by 24% with an additional 5 kg/m² in BMI [37]. In women, relative risks augmented to 59% for endometrial cancer and by 12% for post-menopausal breast cancer [38]. In 2002, in conjunction with obesity; cancer caused 27% of mortality and 17% of DALYs lost in countries such as the UK [15]. Table 1 projects health trends based on QALY's for UK and USA. Although the prevalence of obesity in the UK is less than in the USA, a substantial disease burden is associated with obesity and overweight in the UK population. During the next 20 years, it has been projected that obesity-attributable disease risks will add an excess of 544,000 – 668,000 cases of diabetes, 331,000 – 461,000 of coronary heart disease and strokes, and 87,000 – 130, 000 of cancer [37].

Maternal obesity has significant implications for the health of women and their babies as it is linked to an increased risk of congenital anomalies. HSE reported an increase in obesity among women of childbearing age from 12.0% in 1993 to 18.5% in 2006 [39] and has been associated with increased risks during the antenatal, intrapartum and postnatal periods incur additional demand on NHS maternity services in UK [40]. As with adults, obesity in childhood causes hypertension, dyslipidemia, chronic inflammation, increased blood clotting tendency, endothelial dysfunction, and hyper-insulinaemia and further clustering of cardiovascular disease risk factors, known as the insulin resistance syndrome, has been identified in children as young as 5 years of age [41],[42]. A British cohort study reported, 2-fold increase in mortality risk among overweight adolescents and young adults over 57 years [43]. Pediatric obesity epidemic increases odds of occurrence of Type 2 diabetes, representing noxious consequence through macro-vascular and microvascular sequelae. Psychosocial consequences of obesity are not unheard of. Overweight children as young as age 5 years can develop a negative self-image, and obese adolescents show declining degrees of self-esteem associated with sadness, loneliness, nervousness, and high-risk behaviors [41]. With life-expectancy showing an upward trend, and increase in prevalence of obesity at a much younger age the morbidity statistics are going to rise through chronic disabilities further escalating the associated costs.

Table 1. Projected Health and Quality-Adjusted Life-Year Outcomes 2010–30; adapted [37]

| Projected health and quality-adjusted life-year outcomes 2010–30 under three hypothetical scenarios of population-wide change in body-mass index distribution | UK | | USA | |
|---|--------------|----------------|----------------|----------------|
| | Recent trend | Historic trend | Recent trend | Historic trend |
| Scenario 1. Past trends continue unabated | | | | |
| Diabetes (×1000) | +545 (432) | +668 (159) | +5503 (3524) | +7855 (1618) |
| Coronary heart disease and stroke (×1000) | +331 (407) | +461 (128) | +5365 (3359) | +6836 (1537) |
| Cancer (×1000) | +87 (108) | +130 (34) | +405 (265) | +539 (123) |
| Gain or loss in QALYs (×1000) | –2219 | –6300 | –24 488 | –48 259 |
| Scenario 2. 1% reduction in BMI for every adult at baseline | | | | |
| Diabetes (×1000) | –179 (385) | –202 (139) | –2051 (2922) | –2420 (1461) |
| Coronary heart disease and stroke (×1000) | –122 (374) | –122 (116) | –1431 (2799) | –1704 (1400) |
| Cancer (×1000) | –32 (100) | –33 (33) | –73 (219) | –127 (109) |
| Gain or loss in QALYs (×1000) | +3011 (930) | +3195 (395) | +15 988 (1911) | +16 135 (781) |
| Scenario 3. If obesity rates had remained at 1990 levels | | | | |
| Diabetes (×1000) | –897 (216) | –1021 (159) | –8664 (3524) | –11 016 (1618) |
| Coronary heart disease and stroke (×1000) | –634 (204) | –763 (128) | –7670 (3359) | –9141 (1537) |
| Cancer (×1000) | –177 (54) | –220 (34) | –534 (265) | –668 (123) |
| Gain or loss in QALYs (×1000) | 7073 | +11 155 | +58 177 | +81 948 |

3.3. Obesity as an Economic burden

Obesity not only threatens the wellbeing of individuals due to its association with numerous chronic and acute health disorders [44] but also by incurring substantial costs to the individuals affected and to society, notably from increased health-care costs and lost productivity [37]. Obesity places a burden on public resources in terms of health costs, on employers through lost productivity and on families because of the increasing burden of long-term chronic disability, imposing huge gaps in health and social care [14]. Quantification of the costs from the health consequences of obesity is complex; costs are mediated by factors such as a changing demography, food system, and the economy. The medical costs include management of obesity and use of ambulatory care, hospitalisation, drugs, radiological or laboratory tests, and long term care. In addition to medical costs, society incurs substantial indirect costs from obesity as a result of decreased DALYs, premature mortality (before retirement), economic load of early retirement, disability pensions, and work absenteeism or reduced productivity [37]. In US, these figures totaled to an equivalent of 1 month of lost productivity and cost employers \$3792 per year [45].

In early 20th century, obesity accounted for 2% of health-care costs in France and Australia and nearly 4% in the Netherlands, while in 2003 health-care costs associated with obesity accounted for 4–7% of total expenditure in US [37],[45]. The total cost of CVD to the UK economy is estimated as £30 billion, 60% due to health-care costs [46]. In 2006–07, 46% of total NHS costs (over £43 billion) were due to diseases related to poor diet, physical inactivity, smoking, alcohol and overweight/obesity as shown in Table 2. Of the behavioral risk factors, over £5 billion was spent on overweight/ obesity-related ill health, although this includes costs from poor diet and physical inactivity [47]. In 2007, it was projected ‘*Tackling Obesities: Future Choices*’, that the continuing rise in obesity will add £5.5 billion in medical costs to the National Health Service by 2050 [14].

The economic consequences of childhood obesity are not limited to direct costs, such as medical costs, and indirect, such as job absenteeism but incur later when obese children become obese adults. The estimated annual cost of treating obesity-related illness in adults is \$147 billion and has risen by 27 percent between 1987 and 2001. As obesity is associated with delayed skill acquisition, it is also found to be associated with lower wages, in later life [48].

If trends are to be believed, further increases in obesity in the UK and USA projects an expansion of obesity-related and mostly chronic diseases with substantial implications for health-care expenditure. Compounded by an ageing population, a substantial health-care cost burden is expected in the UK. This projection implies £648 million higher costs annually in 2020 and £2 billion higher costs annually in 2030 will be spent on treating obesity-related diseases [37]. Similar trends have been reported in US but it has been suggested that most estimates are over-reported as increased mortality among obese people may result in a 25% overestimate of direct healthcare costs when using population attributable fraction in cost estimates [49]. These estimates of the economic cost of risk factors for chronic disease to the NHS provide evidence for prioritization of resources for prevention and public health.

Table 2. Original and Updated Economic Costs of Overweight/Obesity to the NHS, Adapted [47]

| Disease Burden and co-morbidities | % of total NHS costs | | PAF | Total NHS costs (£millions) | |
|-----------------------------------|----------------------|-----------|-----|-----------------------------|---------------------------|
| | 1992-1993 | 2006-2007 | | Original costs (2002) | Updated costs (2006 – 07) |
| Ischemic heart disease | 2.6 | 2.9 | 34 | 778 | 801 |
| Ischemic stroke | 4.1 | 1.2 | 34 | 983 | 332 |
| Breast cancer | 0.3 | 0.6 | 12 | 29 | 59 |
| Colon/rectum cancer | 0.5 | 0.5 | 16 | 61 | 65 |
| Hypertensive disease | 1.4 | 4.5 | 58 | 576 | 2121 |
| Corpus uteri cancer | 0.1 | 0.2 | 49 | 41 | 80 |
| Osteoarthritis | 1.6 | 5.0 | 21 | 229 | 853 |
| Diabetes mellitus | 1.0 | 1.3 | 79 | 533 | 835 |
| Total | 11.6 | 16.2 | | 3231 | 5146 |

3.4. Reversing the tide: Prevention holds the key

The unfordable and expensive nature for reversing the obesity tide arises from policies developed to combat obesity. Most of these approaches aim at bringing the problem under control, rather than affecting a cure, and obviously require a multi-disciplinary and intensive regimen. Pharmaceutical approaches may assist, but cannot replace, the multidisciplinary management of obesity [13]. Prevention is the only feasible option and is essential for all affected countries. Developing public health preventive policies to combat obesity is also a much more complex process than anticipated as there are all sorts of political pressures to cope with [19]. There is a wide gap between recommendations and implementation due to political, economic and cultural factors. The rising epidemic reflects the profound changes in society and in behavioural patterns of communities. Therefore, most policies should be woven around communities with new regulatory approaches towards behaviour changes at multiple settings and at all levels of government as seen in Figure 3. Some key policy interventions based on ‘drivers of obesity’ theories have been tabulated in Table 3.

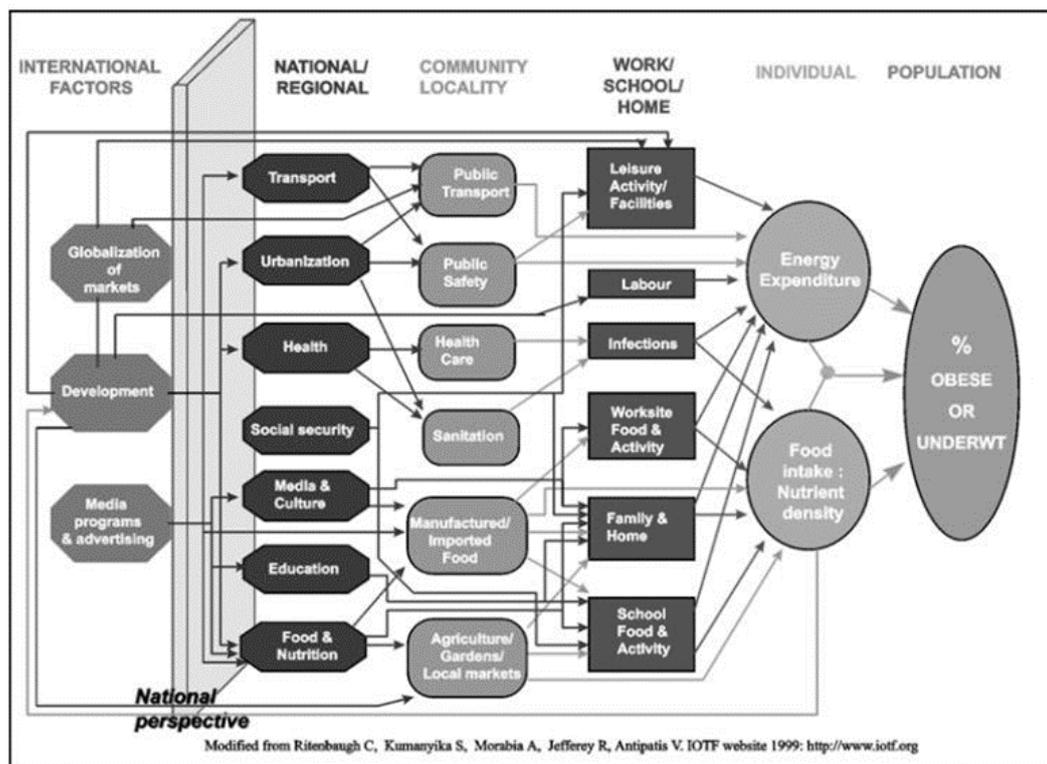


Figure 3. Population Level Policies with Direct and Indirect Influences on The Prevalence of Obesity; Links will Vary between Different Societies and Populations, Adapted [50]

Table 3. The Policy Implications of some Key Theories, Adapted [51]

| Theory | Core argument | Implied solutions |
|------------------------|--|--|
| Genetic causation | The predisposition to lay down fat is an evolutionary legacy | Genomics, gene mapping and nutrigenomics. Functional foods might help play a part in tailoring diets to individual predispositions |
| Economic transition | Lifestyle change is associated with development of a post-industrial consumerist society | Once sufficiently affluent, people will be able to tackle obesity as consumers, choosing or not, as they wish. At the micro level, fiscal measures such as 'fat taxes' could be considered |
| Technological change | Oil as a source of energy is replacing food as source of energy | Build in more physical energy use into daily life. Design technology to help keep intake in balance with expenditure |
| Cultural change | Marketing and advertising instils new cultural norms about what and how to eat, and how much to eat | Social marketing can emulate 'business' marketing |
| Psychosocial | Food choice is intensely personal and expresses identity. Obesity suggests a schism within identity well-being | Family change. Counselling. This is required both individually and on a mass scale |
| Obesogenic environment | Obesity is a normal physiological response to an abnormal or inappropriate environment | Change the physical and dietary environments to allow normal physiological balance to(re)emerge |
| Nutrition transition | Rising income leads to dietary changes, <u>leading to shifts in disease patterns</u> | It is probably too late to prevent rising obesity |

3.5. Population level Approaches

Diet and Nutrition: Focusing of nutritional needs of a population archives the ultimate goal of improving population health Targeting diet and nutrition mean focusing on decreasing the intake of non-milk extrinsic sugars and salt and increasing the consumption of fruit and vegetables (to at least 5 portions a day). Addressing issues such as fair trade, economic viability and accessibility and affordability, *UK Action plan* recommends changes in the supply chain such as increasing consumer demand for healthy food, giving people a better understanding of healthy eating through training, improving food labelling and influencing those who govern and monitor changes in health. Although there have been improvements in food environment and dietary intake some areas, no real-life evidence exists linking these changes with measured changes in body weight in adults [52] or BMI in children [53]. A new regime here would be introduction to "fat tax" over salt- and fat-enriched food items.

Social Marketing: Providing accurate and balanced information' to the general population regarding diet and nutrition as well as physical activity. Social marketing is said to be the most effective strategy for both children and adults as it ranges from raising awareness through mass media campaigns, improving adult literacy and cooking competency skills to marketing strategies that increase awareness about unhealthy choices [14]. **Physical Activity Levels:** All regions have set targets to increase physical activity with England setting the most ambitious target of having 70 percent of adults meet the recommended levels of activity by 2020 and Scotland, 50 percent of Scottish adults by 2022 [54]. Interventions involving built environment, sports clubs and enhanced access, schools, and workplace have resulted in positive outcomes. The most efficient interventions to increase physical activity were community rail-trails, pedometers, and school health education programs and seem to increase physical activity cost-effectively [55]. This strategy has been more effective children.

Community design and infrastructure characteristics ("built environment") have become increasingly prominent in efforts to identify population-level determinants of obesity. Urban "sprawl" is a geographic concept that has recently been studied in relation to risk of obesity and results in large areas of low-population density that encourage and usually require residents to drive from home to work, stores, school, and recreation facilities. Interventions based in schools, work-place, health accommodations and communities are next in line to combat obesity by targeting obesogenic environments.

A new policy-Life Course Approach: Policy interventions to tackle obesity in the devolved regions have been primarily aimed at preventing childhood obesity. This focus has neglected tackling obesity in adulthood and yet age is a significant risk factor for obesity with most obese individuals being adults who account for the majority of obesity-related financial costs. The only approach that combines 'tracking' of conventional risk factors from childhood to adulthood; integrates evidence for 'programming' as a potential model of disease etiology with, in particular, 'the fetal origins of adult disease' hypothesis [56]; and focuses on critical periods might the most cost-effective and feasible approach for many countries and should involve three mutually reinforcing strategies throughout life, starting in the antenatal period.

It is not simple to have population based UK-wide strategic framework for tackling obesity. Besides existence of multiple layers of governance, there are clear demarcations between targets in diet; nutrition and physical activity level between regions some of which are not realistic. Social media and marketing strategy

fails due to distorted perceptions of what qualifies as normal and excess body weight, particularly in relation to the parents of overweight and obese children, have been found to be a significant issue. Managing and sustaining food and nutrition or physical activity policy has its own fiscal limits. Success of these policies and processes are embedded in different sectors-political, economic and social structural levels. Interventions aimed at improving individual lifestyles, have limited access in some areas and this may actually aggravate disparities between the more and less advantaged. Population based approaches target policies and process, aiming for a transition towards healthy population diets, activity levels and weight status. It is essential to understand these aspects differ culturally and between and within countries. Although the beneficial results of such interventions may be long-term, detectable and significant, they are sometimes very small compared with the size of the problem. Moreover, the improvements tend to decline after the intervention ends. It must be concluded that interventions will need a co-ordinated effort by stakeholders at the family or school level, and are to be matched by changes in the social and cultural context so that the benefits can be sustained and enhanced.

4. CONCLUSION

The burden of obesity varies with age, ethnicity, socio-economic status and state economies. All new projections should hence accommodate population ageing, and other population changes such as immigration, health-care system reform, or technological advances for disease treatment for a comprehensible assessment of global burden. There are still no clear and appropriate answers about answer when, where, why, and, how costs accrue in obese populations, further long term commitments are required for the same. Most population-based prevention policies are cost effective, largely paying for themselves through future health gains and resulting reductions in health expenditures. Therefore, these prevention programs should be high on the scientific and political agendas. It is hence, essential to evaluate these policies in new light for all economies and with revived interests for its widespread adverse health consequences.

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