Multiple health behaviours: overview and implications

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ABSTRACT

Background More remains unknown than known about how to optimize multiple health behaviour change.

Methods After reviewing the prevalence and comorbidities among major chronic disease risk behaviours for adults and youth, we consider the origins and applicability of high-risk and population strategies to foster multiple health behaviour change.

Results Findings indicate that health risk behaviours are prevalent, increase with age and co-occur as risk behaviour clusters or bundles.

Conclusions We conclude that both population and high-risk strategies for health behaviour intervention are warranted, potentially synergistic and need intervention design that accounts for substitute and complementary relationships among bundled health behaviours. To maximize positive public health impact, a pressing need exists for bodies of basic and translational science that explain health behaviour bundling. Also needed is applied science that elucidates the following: (1) the optimal number of behaviours to intervene upon; (2) how target behaviours are best selected (e.g. greatest health impact; patient preference or positive effect on bundled behaviours); (3) whether to increase healthy or decrease unhealthy behaviours; (4) whether to intervene on health behaviours simultaneously or sequentially and (5) how to achieve positive synergies across individual-, group- and population-level intervention approaches.

Keywords Risk behaviors, health behaviours, lifestyle risk reduction, multiple health behaviors, behavioral intervention, behavior change, health behavior bundles, risk behavior cluster, preventive medicine

A majority of life-threatening disease around the globe is now chronic and linked to health behaviours. A key property of these behaviours is that they co-occur as risk behaviour clusters or bundles. The mechanisms that give rise to health behaviour bundling are poorly understood, as are their implications for intervention. After characterizing the prevalence of behaviours that have the greatest impact on health, we examine their co-occurrence and consider implications for individual- and population-level interventions to foster healthier behaviours.

Health risk and health protective behaviours

Health risk behaviours are detrimental actions that heighten the odds of illness or impede recovery. At least five categories of behaviour have been consistently found to correlate with increased morbidity and mortality: (1) consuming a diet high in calories, fat and sodium, and low in nutrients; (2) low levels of physical activity and high levels of sedentary activity; (3) smoking cigarettes; (4) abusing substances including alcohol, prescription and illicit drugs; and (5) engaging in risky sexual behaviours.

Conversely, health protective behaviours are actions that reduce disease susceptibility or facilitate restoration of health. Three health protective behaviours are established to be linked with better health and recovery from illness: (1) being physically active; (2) eating fruits and vegetables; and (3) being adherent with prescribed medication. It has been suggested that eliminating health risk behaviours would prevent 80% of heart disease, stroke, type 2 diabetes and 40% of cancers.

Unhealthy behaviours are prevalent. Currently in the USA, fully two-thirds of the population exceeds a healthy weight: 27.2% of American adults are obese; another
36.2% are overweight and the number of obese children in the USA has doubled if not tripled\textsuperscript{22,43} (note that we follow medical convention in characterizing overweight/obesity as a behavioural risk factor even though it is more accurately described as a biomarker or intermediate outcome. In other words, we consider overweight/obesity to be a proxy indicator of a state of positive energy balance that reflects chronic overeating: consuming excess energy intake relative to energy expenditure. Conversely, in referring to diet quality, we designate eating behaviours that result in consuming a nutritionally adequate diet irrespective of energy balance).

Prevalence is similar in England, where approximately 25% of adults were classified as obese in 2009.\textsuperscript{23} Although cigarette smoking is less common, it remains responsible for the largest number of deaths.\textsuperscript{4,45} Presently, 21% of US adults, 20% of high school students and 6% of middle school students smoke cigarettes.\textsuperscript{22,44} Likewise, in England the proportion of adults who report cigarette smoking is 21%.\textsuperscript{23} More than a quarter of English secondary school pupils (27%) have tried smoking at least once and 5% are regular smokers (smoking at least one cigarette a week).

The prevalence of heavy alcohol use appears to be somewhat greater in England than in the USA. Approximately 5.1% of American adults consume more than 1–2 alcoholic beverages per day and 15.5% report binge drinking (consuming at least 4–5 drinks on a single occasion).\textsuperscript{24–28} In comparison, 33% of English men and 16% of women (24% of adults) exhibit hazardous drinking.\textsuperscript{23} Adolescents use alcohol and other drugs at high rates, and they are more likely to engage in unprotected sex when under the influence of drugs or alcohol.\textsuperscript{45,46} In 2009, 34% of currently sexually active US high school students reported not using a condom during last sexual intercourse,\textsuperscript{45} helping to explain why youth between ages 13–24 account for approximately half of the incidence of sexually transmitted disease.\textsuperscript{47} In a different population sector, 36% of men who have sex with men report not using condoms with casual sex partners.\textsuperscript{48}

By comparison to health risk behaviours, health protective behaviours are uncommon. Globally, nearly 2 million deaths per year are attributed to physical inactivity.\textsuperscript{49} According to their own self-report, 46% of college-educated US adults and 21.4% of those without a high school diploma are regularly physically active.\textsuperscript{50} By objective accelerometer assessment, however, only 3.8% of US adults meet public health guidelines for engaging in 30 min of moderate-vigorous activity on at least 5 days per week.\textsuperscript{51} Similarly, results of a large survey conducted in England indicated that 20% of respondents reported walks of at least 20 min ‘less than once a year or never’.\textsuperscript{23}

A healthy diet high in nutrient quality is health protective and includes abundant intake of fruits and vegetables, fish and low intakes of processed meat and dairy products.\textsuperscript{2,42} Yet, only 23.5% of US adults eat five fruits and vegetables per day and, alarmingly, 35% eat no vegetables daily and 57% eat no fruit daily.\textsuperscript{53} The proportion of English adults who eat five portions of fruits and vegetables daily is similar: 25% of men and 28% of women.\textsuperscript{23} Although 69.2% of US adults should consume no more than 1500 mg/day of sodium (i.e. all middle-aged and older adults, all blacks and all persons with hypertension),\textsuperscript{54} in 2004 the Institute of Medicine concluded that the level of sodium in the food supply is so high that intake <2300 mg/day is not readily achievable.\textsuperscript{2,55} The proportion of US adults and children who achieve all four to five components of a healthy diet is even smaller than the proportion that meets physical activity targets: ≏0.5%.\textsuperscript{2} Motivation to preserve health might be expected to be greatest among those who already have chronic disease. In actual practice, however, adherence to the simplest disease management behaviour (pill taking) is typically only about 50%, particularly after the first 6 months of treatment.\textsuperscript{36–38} Non-adherence is ~49% for lipid-lowering agents, 42% for oral anti-diabetic agents and 36% for antihypertensives.\textsuperscript{59}

### Health risk behaviour bundling

#### Adulthood

In addition to being prevalent, health risk behaviours co-occur and most adults display more than one.\textsuperscript{60} A survey of 16,818 adults from the 1998 National Health Interview Survey showed that 52% had two or more risk behaviours from a list that included: physical inactivity, overweight, cigarette smoking and risky drinking.\textsuperscript{61} Fine et al.\textsuperscript{60} analysis of the 2001 National Health Interview Survey examined co-variation among those same four behavioural risk factors (physical inactivity, overweight, cigarette smoking and risky drinking). In their sample of 29,183 adults, the mean number of risk factors was significantly >1 (M = 1.68, 95% CI: 1.66–1.70) and 17% had three or more risk factors. Fine et al. went on to examine patterns of clustering (bundling) among risk behaviours. Of those with three risk factors, the most common grouping was smoking, overweight and lack of physical activity. Of those with two risk factors, the most common bundle (by far) was overweight and lack of physical activity (26%). Smoking and lack of physical activity overlapped for 16%, smoking and overweight for 12% and smoking and risky drinking for 9% of respondents. Greater odds of unhealthy behaviour bundling
were observed among men, those with less than a college education and those with high levels of mental distress.

Prönk et al. investigated the prevalence and bundling of multiple health behaviours among an insured population. The researchers surveyed a random sample of adolescents, adults and seniors from a large Midwestern health plan about physical activity, non-smoking, high-quality diet and healthy weight. Adults and seniors were also asked about their alcohol consumption. Among adolescents, 30.2% had two or more of the four queried unhealthy lifestyle behaviours. Among adults, the number rose sharply to 72.3% who manifested two or more of the five possible unhealthy behaviours; among seniors that proportion was 51%. Considering only the four unhealthy behaviours that all groups could have, across all ages the average proportion of those showing two or more risk behaviours was 55.7 and 19.7% had three or more of these risk factors. Among adolescents, being depressed increased the odds of having multiple risk behaviours, a finding that has been replicated by Katon et al. Conversely, for adults and seniors, having a college degree decreased the likelihood of exhibiting multiple unhealthy lifestyle behaviours.

Youth
As children and adolescents form unhealthy habits that contribute to the development of disease biomarkers, they launch trajectories toward chronic disease. The odds of having multiple risk behaviours increases over the course of development, especially during the teenage years. Through experimentation with substances and physical risks, some adolescents acquire unhealthy behaviours and friends that persist and discourage the development of other self-regulatory skills. For example, DuRant et al. surveyed 2227 middle school students between the ages of 11 and 16 years about 16 risk behaviours, including substance use and behaviours that convey risk of physical harm (e.g. fighting, carrying a weapon, seatbelt and helmet use). Results showed that having smoked by age 11 explained 21.9% of the variance in all other risk behaviours. Adding early onset of other substance use (alcohol, marijuana and cocaine) to the model plus male gender, low academic performance and race accounted for 51.2% of the variation in all of the risk behaviours under study.

Cross-culturally, risk behaviours are seen to grow in prevalence and multiplicity over the course of adolescence. Brener et al. surveyed 10 645 American youth between ages 12 and 21 about physical safety practices, substance use and risky sexual behaviours. Whereas only 8.3% of adolescents aged 12–13 years engaged in two or more risk behaviours, 33% of those aged 14–17 years and 50% of 18–21-year-old youth did so. Being male and out of school were associated with engaging in multiple risk behaviours. A similar age-related increase in the multiplicity of risky substance use and sexual practices was observed also in rural Laos. Among 1360 Laotian boys and girls between the ages of 14 and 19 years, being 15 years or older, and having peers who smoke, drink or have sex were associated with greater odds of having multiple risk behaviours. In that study, about 46.8% of youth reported no risk behaviours; 39.3% reported one; 8.1% reported two and 5.8% reported more than two risk behaviours.

Adolescents’ more action-oriented, impulsive risk behaviours have a complex pattern of associations with the diet and activity chronic disease risk behaviours that predispose toward chronic disease. In a study of early adolescents, Farhat et al. surveyed 7825 US school children between ages 11 and 17 who participated in the 2005–2006 World Health Organization Health Behaviours in School-Aged Children Survey. Results showed that overweight/obesity was associated with substance use (frequent smoking, cannabis use and drinking) chiefly among girls. In contrast, among boys 15 years or older, obesity was associated with double the odds of carrying a weapon. Studying a slightly older population (5537 high-school students), Basen-Engquist et al. observed that not participating in aerobic activity clustered with behaviours reflecting intake of a high-fat diet, and that non-participation in sports activities clustered with low fruit and vegetable intake and poor academic performance. In turn, smoking, drinking, marijuana use, unsafe sex and risky driving clustered together, and harder drug use (cocaïne, injection drugs) was represented in a different cluster that included fighting and carrying a weapon.

By older adolescence, college students appear to have grown into the pattern of bundled chronic disease risk behaviours we described earlier for adults. For example, among German university students, 87.5% had two or more of a roster of four unhealthy behaviours that included: low fruit and vegetable intake, low physical activity, tobacco use and excessive alcohol use. Only 2% had none, 10.5% had one, 34.5% had two, 34.8% had three and 18.2% showed all four risk behaviours.

Multiple health behaviours, morbidity, and mortality
Health risk and health protective behaviours are important because they are linked cumulatively to cardiovascular and all-cause mortality. In the European Prospective
Investigation of Cancer—Norfolk study that followed 20,244 British adults for 11 years, having four compared with zero healthy lifestyle behaviours (diet, smoking, alcohol and physical activity) was associated with a 4-fold difference in mortality.78 Similarly, among participants in the Cancer Prevention Study-II Nutrition Cohort, a composite measure of healthy lifestyle was related to reduced risk of premature mortality from cancer, cardiovascular disease and all-cause mortality.79 Likewise, based on findings from the Japan Collaborative Cohort (JACC) study, Tamokoski et al. observed that a composite measure of multiple health behaviours predicted preventable death, above and beyond the predictive value of any single lifestyle behaviour.

**Conceptualization of multiple health behaviour linkages**

For simplicity, we have used the terms risk behaviour ‘clustering’ and ‘bundling’ interchangeably throughout this paper. Before closing, though, we should note that these terms originate from different scholarly traditions and have somewhat different nuances. Epidemiologists have used the term ‘clustering’ to describe co-occurrence of unhealthy behaviours among population subgroups at a high risk of chronic disease. The observation that risk behaviours are most prevalent in disadvantaged sectors of the population has been understood to mean that shared social determinants (e.g. poverty, chronic stress and adverse environment) give rise to clustering of unhealthy behaviours in the population.81,82 Because a common aetiology (disadvantage) has been held accountable for risk behaviour clustering, a plausible epidemiological hypothesis has been that provision of resources (e.g. information, education and environmental improvements) will improve health behaviours largely in parallel.

In the behavioural sciences, the premise that symmetrical healthy changes will result from health promotion interventions is less often assumed. Behavioural scientists often invoke the concept of ‘behaviour bundling’ to guide intervention development by characterizing how an individual’s health behaviours are functionally interrelated. The underlying premise is that many lifestyle behaviours are served by the same neural circuitry that calls upon shared, limited self-regulatory resources and aims (e.g. to acquire positive reinforcement).83,84 An implication is that when intervening upon one health behaviour, corollary changes in other health behaviours can be expected.84 Health behaviour bundling suggests substitute and complementary relationships, such that changing one behaviour may crowd out or make room for interconnected behaviours or, alternatively, bring along, tag-along, same direction changes in linked actions.85 An individual-level example of risk behaviour bundling is that when cigarette smoking is scaled back, the reward value of treat foods increases, as does their consumption, resulting in a weight gain.86–88 Presumably that is the reason why trying to cut down on two rewarding substances (cigarettes and treat foods) simultaneously is less effective in conjointly managing smoking and weight than is achieving smoking cessation first and then addressing weight management, sequentially after a short lag.89 A population-level example of behavioural substitution is that the anticipated reduction in blood pressure that is expected to result from smoking cessation generally fails to be observed on a population level because eating and body weight increase.10 Another population-level example of behavioural substitution that occurred entirely within the realm of eating behaviours and took US public health officials by surprise occurred when the successful campaign to reduce intake of dietary fat led calorie intake to increase between 1971 and 2000 largely because carbohydrate intake increased.11 An example of an adverse population-level complementary behaviour change is the finding that early onset of smoking tends to be accompanied by the onset of additional risk behaviours.72

**Implications for intervention**

Healthy lifestyle promotion must be a centrepiece of efforts to improve public health because health risk behaviours are as strongly associated as risk biomarkers with the onset of chronic disease.90 A comprehensive approach to healthy lifestyle intervention should include both primordial prevention, to deter risk behaviours and risk biomarkers from emerging, and primary prevention, to control existing risk factors and prevent the onset of clinical disease.52,64,66,67 Desired outcomes are the prevention of early death, compression of morbidity until the end of life and enhancement of productivity and quality of life.

The optimal balance between targeted high-risk versus broader population preventive strategies is often debated.12,81 Our view is that the two strategies act synergistically and are both necessary. The high-risk approach entails identifying the most disease-susceptible population subgroup, traditionally via biomarker screening (e.g. for high cholesterol, hyperglycemia, etc.) and offering them preventive treatment, traditionally via medications. In contrast, the ‘population strategy’ seeks to control the determinants of illness in the entire population, by intervening broadly, usually against environmental factors that make a disease prevalent.12,81 The merits of a combined approach are discernible from the observation that targeted medical
treatment of high-risk individuals and population-wide improvements in health behaviours accounted almost equally for the decline in the US coronary artery disease mortality between 1980 and 2000.13

One critique of the high-risk approach has been that the untargeted majority of the population without risk factors actually gives rise to most cases of disease.81 Another is that screening inevitably results in false-positive cases that receive unnecessary, usually chronic and expensive medical treatment.81 To our minds, these critiques are largely irrelevant to behavioural high-risk approaches because behavioural risks actually characterize the majority rather than a subgroup of the population. Additionally, behavioural risk factors usually can be treated effectively by time-limited, rather than lifelong behavioural or pharmacologic treatment. In contrast to the high-risk approach, the population strategy seeks to produce small population-wide improvements, traditionally in biomedical risk factors, by means of universal environmental changes and policies (e.g. taxes, subsidies and laws) that aim to make healthy behaviours the default choice. By virtue of their broad reach and community penetration, policy interventions can achieve considerable impact. For example, if the National Sodium Reduction Initiative could induce food companies to reduce the amount of salt in the US food supply to the 1500 mg/day or less level that the Institute of Medicine recommends,55 there would be a 25.6% overall decrease in high blood pressure and $26.2 billion in healthcare savings.14

Often overlooked, however, is that the small biomarker improvements targeted by population-level intervention can require quite large changes in behaviour to achieve. Intensive, multi-session behavioural interventions are vastly more effective than less intensive approaches at producing the 5–7% weight loss15 or smoking cessation16 needed to improve risk biomarkers.17 Because public health impact is the product of treatment effectiveness multiplied by population reach, both policy level (superior reach) and intensive behavioural change interventions (superior effectiveness) are cost-effective,52 and a combined strategy is optimal. For example, Levy et al.18 recently demonstrated that reducing the prevalence of US tobacco use to 12% by 2012 requires not only environmental changes that prompt more quit attempts, but also ensuring greater uptake and adherence to effective smoking cessation treatments.

At this juncture, it is probably accurate to state that more remains unknown than known about how to optimize multiple health behaviour change at the individual or the population level. Important, unresolved policy- and practice-relevant questions that need investigation include: (1) the optimal number of behaviours to intervene upon; (2) best practices to select which behaviours to target for change (e.g. greatest health impact; patient preference or greatest positive carry-over effects on bundled behaviours); (3) whether to increase healthy or decrease unhealthy behaviours; (4) whether to intervene on health behaviours simultaneously or sequentially,89 and (5) how to achieve positive synergies across individual-, group- and population-level interventions.84 Having the capacity to prevent the onset of risk behaviour clusters or intervene synergistically to improve many health behaviours would have substantial public health impact. There is a pressing need for a body of basic, translational and applied science to help tackle the co-occurring health risk behaviours that characterize most adults.

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