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# Empirically derived dietary-lifestyle patterns and cardiometabolic health in young men: a review

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Sex and gender are important factors that impact cardiometabolic traits. Men have lower life expectancy and higher prevalence of fatal chronic conditions at younger age. Lifestyle risk profiles in young men have been rarely studied in the context of cardiometabolic health. This review aimed to summarise the evidence regarding the patterns of dietary-lifestyle behaviours in a population of young men (age <40years) and their associations with cardiometabolic health. Overall, unfavourable clusters of health behaviours are more prominent in men, when compared to women and more prevalent in younger adults, when compared to older age groups. Early signs of cardiometabolic health abnormalities have been reported among men with higher adherence to patterns which consistently shared poor dietary habits as a common denominator, combined with stimulant use, inadequate sleep or insufficient physical activity. In the majority of studies, dietary assessment was limited to the investigation of one or two behaviours, most frequently fruit and vegetable intake. Since young men may engage in a mixture of explicit behaviours, the examination of a singular dietary habit may not represent the overall diet quality. To conclude, the data regarding the synergistic effects of a broad spectrum of dietary and lifestyle behaviours in the context of cardiometabolic health remain scarce in this population. The inclusion of a broader range of dietary and lifestyle variables into the multicomponent pattern analysis might have a greater potential in explaining the association with cardiometabolic health. Defining behavioural clusters can help to develop interventions, tailored to the specific needs of the targeted group.

**Cardiometabolic: Behavioural clusters: Diet: Lifestyle: Patterns: Young men**

Sex and gender are important factors that have an impact on cardiometabolic traits[1]. Men have a lower life expectancy as well as a higher prevalence of fatal chronic conditions and heart disease at a younger age, with premature mortality due to non-communicable diseases in men being identified as one of the leading public health challenges[2–4]. Health inequalities between men and women can be explained by sex-related biological differences, genetic predisposition and lifestyle factors[1]. Lifestyle risk profiles in young men, as modifiable factors, have been rarely studied in the context of cardiometabolic health. This is of particular concern since behaviours acquired in young adulthood may trigger pathophysiological processes with immediate or delayed health consequences[5,6].

A few particularly concerning health issues that affect more often young men than women include hypertension, heart and circulatory diseases, particularly acute myocardial infarction and sudden cardiac death[7–11]. In the American cohort of young adults (age 18–39 years), men had a substantially higher prevalence of prehypertension compared to young adult women (34 *v.* 13 %), and at the same time significantly lower awareness, treatment and control (68 *v.* 86 %; 44 *v.* 61 % and 34 *v.* 52 %,

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men *v.* women, respectively)[7]. Although the authors speculated that this could be explained by less frequent medical check-ups among men, the sex-related inequalities in the incidence of CVD are not limited to behavioural factors. The intrinsic biological, hormonal and genetic factors are also studied. The vascular ageing (endothelial dysfunction and arterial stiffness) begins earlier in life in men than in women, which eventually evens out in the sixth decade of life[12]. This delay in the onset of CVD in women can be partially explained by the protective effect of higher oestrogen levels prior to the menopause[12]. Moreover, it has been suggested that higher predisposition to coronary artery disease in young men is associated with the paternal lineage of their Y chromosome, which increases the risk in this population segment[13]. Interestingly, the research group found that men who inherited one of the most common Y chromosome types in Europe (haplogroup I) from their male ancestors had a 50 % higher risk of coronary artery disease than do men with other types of the Y chromosome[13]. Further health disparities in this group are observed within Europe. The prevalence of premature mortality is higher in men from eastern European countries, than in the Western countries[14]. In Poland, all-cause mortality is five times higher in men than women under 45 years old[15]. Although a large proportion of these deaths is due to external causes (38 %), the deaths due to CVD in this age group are 3·5 times higher in Polish men than women of the same age[15].

According to the recent epidemiological data, a new epidemic of CVD is forecasted in the young adult population segment as they grow older[16]. The authors analysed the trends in the incidence of CVD in developed countries and observed a decreasing trend in adults >50 years old. In contrast, within the same period of time, this trend in younger adults has either been steady or increasing, depending on the country[16]. Due to the increasing prevalence of unhealthy risk behaviours among young individuals, it can be expected that the future generation of adults >50 years old will enter the sixth decade of life with a worse cardiovascular risk profile than the present population of mature adults.

It is unclear to what extent lifestyle factors can counterbalance the physiological and genetic predisposition to the diseases; however, it can be expected that morbidity and premature mortality could be reduced with appropriate lifestyle changes in this age group. In general, risky health behaviours are more prevalent in men, than women. Olson *et al.*[17] investigated health behaviours in an American cohort aged 24–32 years and discovered that men exceeded women in all investigated outcomes, such as binge drinking, smoking, drug use, avoiding medical check-ups and fast-food consumption. The only exception was physical activity; the higher percentage of men was active in comparison to women[17]. Although it has been well established that men are more likely to engage in unhealthy behaviours than women[18–20], there is a gap in the understanding of which particular dietary behaviours tend to cluster with other lifestyle behaviours. Only a few studies reported clusters of dietary and lifestyle behaviours specific to the population of young men[21], despite strong recommendations to analyse behavioural patterns using age and gender stratification[22]. Defining behavioural clusters in this group could help to develop targeted interventions.

There are many approaches to defining early adulthood. For the purpose of the present paper, we will follow Levinson[23] who suggested that early adulthood begins around age 22 years and ends at 40 years. The prelude to this stage of life is described as an early adult transition, which begins at age 17 years [23]. Both of these early periods of life encompass great levels of stress associated with the changing of societal roles of a young man, e.g. becoming a student, an employee, a husband, a parent[23,24]. It is also time when the cardiovascular system is functioning at maximum capacity and when most of the biological peaks occur, such as muscle strength or bone mass[25–27]. Hence, it is crucial to ensure that during this time, the body will benefit from optimal nutrition and health-promoting lifestyle behaviours, which would enable the build-up of the 'health bank' for the consequent decades of life, as well as support the mental health to alleviate the effects of stress.

This review aimed to summarise the evidence from cross-sectional studies regarding the patterns of dietary-lifestyle behaviours in the young male population and their potential associations with cardiometabolic health. The studies discussed in this review focused on empirically derived patterns, clustering a dietary component with at least one of the following health behaviours: smoking, alcohol use or physical activity.

## Approaches to studying behavioural clusters

Health behaviours have been defined as overt behavioural patterns, actions and habits that relate to health maintenance, to health restoration and to health improvement[28]. In the literature, these are usually considered in a broad or narrow context. Behaviours *sensu largo* include a whole spectrum, including diet, physical activity, substance use, sexual activity, environmental hazard avoidance, preventive health and safety practices, e.g. seatbelt use[29]. Health behaviours *sensu stricto* are usually limited to behaviours often abbreviated as SNAP: smoking, nutrition, alcohol and physical activity[30] also known as the big four[3].

Two methodological approaches in studying the clustering of health behaviours can be considered: *a priori* and *a posteriori*. The first approach is hypothesis-driven. Based on the previous knowledge, the predefined dietary and lifestyle risk factors are selected and its cumulative effect on health is investigated. The results of studies which applied this approach were the keystone in public health research, documenting the detrimental effects of the main four modifiable lifestyle behaviours on health[31]. As can be predicted, the cumulative effect of all four behaviours (SNAP) generates the highest health risk[32]. However, it has not been clearly specified which components of these behaviours in particular would create the clusters (patterns) of the highest or lowest risk to health.

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To answer this research question, the *a posterori* approach needs to be applied. This means that the patterns of behaviours are derived with the use of multidimensional statistical techniques based on the available data, rather than the researcher's hypothesis[33,34]. Most commonly applied techniques include factor analysis, latent class or principal component analysis. Next, the associations are being investigated between the derived clusters (commonly named patterns, e.g. dietary patterns or dietary-lifestyle patterns) and health outcomes using modelling, e.g. regression analysis or survival analysis[35]. The exploratory nature of this technique means that initially the components (sets of variables) are not known to the researcher and no assumptions can bias the results. This approach helps to obtain objective, often unexpected results which could not be predicted and investigated with the use of an *a priori* approach. This approach received a great deal of interest in the past decade, documenting the specific dietary patterns in various subpopulations[36,37]. However, the evidence regarding the clusters of combined dietary and lifestyle behaviours remains scarce, particularly in young men. In this study, we will focus on the published research, which applied the *a posteriori* approach, often referred to as the empirical method.

## Clustering of dietary-lifestyle behaviours in young men

A recent review pooled data from fifty-six studies in adults (both men and women)[21]. The authors found that being a male, with lower socioeconomic status and younger age is associated with adherence to riskier clusters. Often, those risky clusters had a common denominator: alcohol use and smoking. The authors also highlighted that diet was less often included in the reviewed studies in comparison to alcohol use and smoking. Moreover, the dietary component was often limited to one or two variables, e.g. the frequency of fruit and vegetable consumption or breakfast skipping. Interestingly, the associations with physical activity were unclear. In general, poor diet tends to cluster with substance use (alcohol, tobacco and/or drug use). Clusters differed depending on the sample (e.g. general population *v.* students), country and analytical methods used[21].

The reasons behind the clustering can be broken down into three segments: cognitive, social and biological[38]. The cognitive reasons are linked to the theory of reasoned action and determinants such as intentions, self-efficacy, outcome expectancies, perceived susceptibility and perceived severity[39]. It has been previously documented that men display a lower level of nutritional knowledge than women[40]. Furthermore, in men, nutritional knowledge is not a direct predictor of healthy eating attitudes[41,42]. This would explain why some behaviours in men remain inconsistent, for example, as mentioned earlier, there is no clear association between physical activity and diet or substance use; men can have unhealthy dietary habits and at the same time be highly active[21]. Gubbels *et al.*[43] identified a cluster in boys labelled as Sports-Computer, which was characterised by health-promoting dietary behaviours, sedentary time and using a computer as well as being physically active. Although the authors studied behaviours in a sample of children, this example shows that some behaviours that may appear to be contradictory often coexist, and this phenomenon can be revealed using the data-driven approach.

Social reasons for the clustering of behaviours are related to age, sex, socioeconomic status, education, and these determinants appear to be the most frequently studied in lifestyle research[19,44,45]. These will be discussed in more detail further in the review. Lastly, biological explanations are associated with physical and mental health. It has been suggested that sex-related differences in lifestyle behaviours might be linked to hormonal differences[46]. Higher levels of androgens and cortisol, and lower serotonin levels in men may increase the desire for intense sensations and experiences, which can be obtained with the use of stimulants[46]. It has been shown that men have different responses to stress than women, with one of the avoidant coping strategies is alcohol or substance use[46]. The psychological aspects of lifestyle behaviours have been previously described by Conry *et al.*[47] Among six identified clusters, authors found that the multiple unhealthy behaviours reflected in 'multiple risk factor' and 'physically inactive' clusters, more prevalent in menaged 18–29 years, were associated with lower levels of energy and vitality and highest psychological distress[47].

Due to the cross-sectional design of these studies, the results need to be cautiously interpreted. The potential reason can be either a cause or a result of certain behaviours, e.g. psychological distress can be a cause of unhealthy lifestyle choices but also a result of long-term poor lifestyle habits.

## Clusters of dietary-lifestyle behaviours and cardiometabolic health

Although a number of studies have investigated the clusters of lifestyle behaviours in mixed-sex population, the number of studies in young men which used empirical methods and included a dietary component is very small. A study by Lawrence *et al.*[48] investigated the associations between lifestyle clusters and cardiovascular health in a large American cohort. Eight indicators were used to create a cardiovascular risk scale (systolic and diastolic blood pressure, pulse rate, Hb A1c, TAG, HDL- and LDL-cholesterol, BMI). The results revealed that two clusters named 'inactive, poor diet, poor sleep' and 'consistently negative' were the predictors of poorer cardiovascular health in young adults (aged 26–31) when compared to the 'consistently positive' cluster. However, these results were not sex-specific and only two dietary variables were used to assess the diet quality: frequency consumption of fast-foods and sugary beverages[48].

Another interesting study, by Greene *et al.*[49], investigated the clustering of diet, physical activity, psychosocial factors and elevated health risk associated with obesity. The authors found that male students (aged 18–24) from the cluster labelled as 'psychosocially secure'

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had better adiposity outcomes than men from other clusters, despite the lowest intake of fruit and vegetables and the lowest level of physical activity[49]. This paradox again shows that investigating only one aspect of a diet (here mean daily fruit and vegetable intake) may be insufficient to reflect overall diet quality.

In our recent study in young men (age <40 years), we proposed to include a broader spectrum of dietary variables along with lifestyle behaviours, such as physical activity at work and free time, current and past smoking, alcohol use and screen time[50]. Using a data-driven approach, we identified four dietary-lifestyle patterns. The early cardiometabolic risks associated with adiposity were observed in two dietary-lifestyle patterns labelled 'sandwiches and convenient diet' and 'fast-foods and stimulants', while two other dietary-lifestyle patterns appeared to be protective; due to its components, these were labelled 'protein food, fried-food and recreational physical activity' and 'healthy diet, active, past smokers'. Both of these dietary-lifestyle patterns were associated with lower odds of obesity and lower risks of elevated total cholesterol (only 'protein food, fried-food and recreational physical activity') and fasting blood glucose (only 'healthy diet, active, past smokers'), despite some unhealthy components such as frequent consumption of fried foods or smoking in the past. It could be that the physical activity component present in both patterns, alleviated the effect of the unhealthy behaviours[50]. This study, however, highlights that studying the dietary-lifestyle patterns using the empirical method mirrors the behaviours truly existing in populations (rather than compliance to guidelines recommendations). We believe that this approach more closely represents the real-life scenario, i.e. studies have shown that only a small percentage of the population entirely follow dietary recommendations, whereas a higher percentage display more relaxed, yet still pro-healthy dietary behaviours that can still be protective and used as an example for the rest of the population. There is an increasing recognition among academics and practitioners that health guidelines and interventions should be informed by the evidence obtained for the behaviour patterns research[51]. Researching patterns, rather than individual health-related behaviours, recognise the fact that lifestyle behaviours are complex and may have synergistic or antagonistic effects on the human body.

## Practical implications

Modifying lifestyle behaviours in this population pose a serious challenge. Men are described as a population not only hard-to-reach but also hard-to-engage[52]. It is also unclear whether single or multiple health behaviour change interventions are more effective[53]. In the scoping review, Ashton *et al.*[54] identified forty-six interventional studies which have targeted risk behaviours solely in young men (age 17–35 years) and fifty-four studies reporting outcomes with stratification for age and/or sex. Only a fraction of studies targeted poor diet (*n* 5), with the majority of the interventions being focused on increasing physical inactivity, lowering alcohol use and reducing risky sexual behaviours[54]. The important limitation in terms of applicability of the results was low diversity. Most often, the samples consisted of university students (being a population easily accessible to the researchers). Based on the studies included in the review, the authors concluded that the effectiveness of future interventions can be improved by: (i) being tailored to the specific subpopulations of men (e.g. unemployed, ethnic minorities, etc.); (ii) accounting for the different types of masculinity; (ii) incorporating theoretical frameworks; (iii) choosing the right delivery channel (face-to-face or online intervention), as well as intervention facilitator, similar to the targeted group[54]. Football Fans in Training (https://ffit.org.uk/) is a good example of a successful, age- and sex-sensitised, health-promoting initiative [55–57]. The 12-week intervention directed to overweight men aged 35–65 was delivered in Scottish football clubs by community coaches and involved dietary guidance and physical activity sessions[55]. Participating men managed to implement lasting lifestyle changes, lose bodyweight, improve blood pressure and increase self-esteem[55–57]. The appeal and success of the intervention were attributed to feeling similar to other men in the group, sharing similar interests, filling sessions with effervescent experiences and receiving continuous peer-support[57].

Getting to know the target population is fundamental. The European Commission on Men's Health has stressed the fact that behavioural sex-related differences represent different needs and perceived barriers in terms of health promotion[58]. In further work, Ashton *et al.*[59] suggested that focus groups might be helpful in identifying young men's motivators and perceived barriers towards eating healthily and being active. In this group of 18–25 years-old men, the main motivators for healthy eating were physical health, sport or performance, physical appearance and social influences, while key motivators for physical activity were physical appearance, social inclusion, physical and mental health and improvements for sport or performance[59]. Hence, it may be concluded that the 'one size fits all' approach is not feasible and a thorough analysis of the targeted population is recommended to design the intervention accordingly to the specific needs.

## Recommendations for future studies

In the majority of studies, the dietary component was often limited to one or two variables, most commonly the frequency of fruit and vegetable consumption. It can be argued that the intake of fruit and vegetables is a reasonable indicator of diet quality. It is the food group included in all dietary indices designed to assess diet quality[60,61] and its high intake is associated with the reduced risk of CVD, cancer and mortality[62]. Hence, it might be presumed that high fruit and vegetable intake is a key marker of healthy dietary pattern. This has been previously confirmed by Ramsay

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*et al.*[63] in a study in children. Those who consumed whole fruit, fruit juice and non-starchy vegetables (apart from white potatoes) had higher diet quality measured with healthy eating index (HEI-2010)[63]. However, the results from this sample cannot be generalised to other populations and older age groups. Moreover, studying only a singular dietary behaviour reflects the level of adherence to that particular dietary recommendation and does not expose the nuances in the complexity of human behaviour. As shown before, young men may engage in a mixture of explicit dietary behaviours[49] and therefore in this case, the examination of a singular dietary habit does not represent the overall diet quality. Lastly, from the public health perspective, examining solely fruit and vegetable intake or breakfast skipping will not highlight other areas which require improvement and should be addressed in the target population.

Similarly, variables such as smoking, alcohol use or physical activity would benefit from a more in-depth assessment if used as variables in data-driven analyses. A detailed description of those behaviours could add to the existing knowledge, by revealing what specific types of lifestyle behaviours generate the highest risks and which ones might be protective, e.g. smoking (past, current, frequency, tobacco or electronic cigarettes), alcohol consumption (type, frequency, amount per drinking occasion), physical activity (recreational *v.* physical labour, moderate *v.* vigorous intensity, etc.).

## Conclusions

Young men are a population at high risk of unfavourable health behaviours. Poor diet tends to cluster with stimulants use, but its correlation with physical activity is inconsistent in young men. The data regarding the synergistic effects of a broad spectrum of dietary behaviours combined with other lifestyle factors in the context of cardiometabolic health remain scarce in this population. The inclusion of a broader range of dietary and lifestyle variables into the multicomponent analysis of dietary and lifestyle patterns might have a greater potential in explaining the association with cardiometabolic health. Defining behavioural clusters in young men can help to develop lifestyle interventions, tailored to the specificity and needs of the targeted group.

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## Conflict of Interest

None.

## Author contributors

M. L. led the writing of the manuscript and revised it critically for important intellectual content. L. W. assisted in drafting the manuscript and revised it critically for important intellectual content.

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