The clustering of lifestyle behaviours in New Zealand and their relationship with optimal wellbeing

Kate B. Prendergast

Lisa M. Mackay

Grant M. Schofield

Auckland University of Technology, Private Bag 92006, Auckland, 1142, New Zealand

Please address all correspondence to

Kate Prendergast

Human Potential Centre

Auckland University of Technology

Private Bag 92006

Auckland, 1142

New Zealand

Phone: +64 921 9999 ext 7855

Email: kate.prendergast@aut.ac.nz

Acknowledgements

The authors would like to acknowledge Sovereign's ongoing support as the funder of this research.

KP was supported by a Sovereign Wellbeing Index Doctoral Scholarship.

Abstract

Purpose. The purpose of this research was to determine (1) associations between multiple lifestyle behaviours and optimal wellbeing and (2) the extent to which five lifestyle behaviours—sleep, physical activity, sedentary behaviour, sugary drink consumption, and fruit and vegetable intake—cluster in a national sample.

Methods. A national sample of New Zealand adults participated in a web-based wellbeing survey. Five lifestyle behaviours—sleep, physical activity, sedentary behaviour, sugary drink consumption, and fruit and vegetable intake—were dichotomised into healthy (meets recommendations) and unhealthy (does not meet recommendations) categories. Optimal wellbeing was calculated using a multi-dimensional flourishing scale and binary logistic regression analysis was used to calculate the relationship between multiple healthy behaviours and optimal wellbeing. Clustering was examined by comparing the observed and expected prevalence rates (O/E) of healthy and unhealthy two-, three-, four-, and five-behaviour combinations.

Results. Data from 9,425 participants show those engaging in 4-5 healthy behaviours (23%) were 4.7 (95% confidence interval (CI) 3.8-5.7) times more likely to achieve optimal wellbeing compared to those engaging in 0-1 healthy behaviour (21%). Clustering was observed for healthy (5%, O/E 2.0, 95% CI 1.8-2.2) and unhealthy (5%, O/E 2.1, 95% CI 1.9-2.3) five-behaviour combinations and for four- and three- behaviour combinations. At the two-behaviour level healthy fruit and vegetable intake clustered with all behaviours, except sleep which did not cluster with any behaviour.

Conclusions. Multiple lifestyle behaviours were positively associated with optimal wellbeing. The results show lifestyle behaviours cluster providing support for multiple behaviour lifestyle-based interventions for optimising wellbeing.

Keywords

Lifestyle behaviours, wellbeing, positive health, flourishing

Introduction

Positive health is an emerging paradigm where health is considered beyond the absence of disease [1-3]. Within this paradigm optimal wellbeing, or flourishing as it is also referred, epitomises positive health. Optimal wellbeing has been operationalised as a multi-dimensional construct incorporating measures of feeling good (e.g. positive emotion, vitality, and resilience) and functioning well (e.g. engagement, competence, and meaning) [4]. Recent epidemiological evidence shows the prevalence of optimal wellbeing in New Zealand is low, with 75% of the population failing to achieve optimal wellbeing [5]. Similar, low levels of optimal wellbeing have been reported in many European countries [4]. It is evident from these findings that identifying and promoting behaviours associated with increased wellbeing is warranted.

Walsh [6] argues health professionals have significantly underestimated the importance of lifestyle behaviours for mental health. There is now plausible evidence to indicate individual healthy lifestyle behaviours are associated with optimal wellbeing [5, 7]. Furthermore, findings from a recent study show those who engage in fewer health risk behaviours were more likely to be satisfied with their lives [3]. However, it is currently unknown whether a similar positive association occurs between engaging in multiple healthy lifestyle behaviours and optimal wellbeing. As well as understanding the relationship between multiple behaviours and optimal wellbeing, examining the distribution of these behaviours within the population would be useful for

intervention planning [8]. If lifestyle behaviours cluster, interventions targeting multiple lifestyle behaviours may be more efficient and cost effective than promoting lifestyle behaviours in isolation [9].

Clustering can be used to examine whether lifestyle behaviours co-occur or occur independently in a population [10]. In previous studies, between three and five lifestyle behaviours have been dichotomised into healthy (e.g. meets physical activity recommendations) and unhealthy (does not meet physical activity recommendations) behaviours and the clustering of healthy and unhealthy behaviour combinations have been explored [10-13]. Whilst there is now increasing international research in this area, evidence on the clustering of lifestyle behaviours in New Zealand is limited and the findings mixed [12, 13]. Tobias et al. [12], for example, examined the clustering of four lifestyle behaviours—physical activity, fruit and vegetable intake, alcohol, and smoking—in a sample of 10,241 New Zealand adults with no history of cardiovascular disease or cancer. The authors found unhealthy lifestyle behaviours clustered together; however healthy lifestyle behaviours clustered to a lesser degree. In a more recent study, Williden et al. [13] examined the clustering of body mass index and two lifestyle behaviours—physical activity and fruit and vegetable consumption—in a sample of 1,296 white-collared employees. In contrast to Tobias et al.'s [12] results, no evidence was found to support the clustering of healthy or unhealthy lifestyle behaviours [13]. These contrasting findings indicate further research is needed to develop a more comprehensive understanding of the distribution of lifestyle behaviours in New Zealand.

The selection of lifestyle behaviours has varied in both the international [8, 14-17] and national [12, 13] clustering literature. Nonetheless, most of the lifestyle behaviours investigated in these studies were chosen due to their explicit associations with chronic disease (e.g. lack of physical activity, inadequate fruit and vegetable intake, alcohol consumption, and smoking) [8, 12-17]. Few studies have, however, explored the clustering of other lifestyle behaviours—including sedentary behaviour, sleep, or sugar consumption—which are not only associated with health [18-20] but also wellbeing [5, 21]. There is now substantial evidence to show sedentary behaviour, for example, is adversely associated with health [18] and wellbeing [5, 21]; independently of physical activity. Similarly, inverse associations between sugar consumption and health [20] and wellbeing [5] have been documented in the literature. Understanding how lifestyle behaviours associated with health and wellbeing are dispersed across the population would be useful for informing positive health interventions. The aims of this study are two-fold: (1) To advance the literature by determining the association between multiple lifestyle behaviours and optimal wellbeing; and (2) To extend beyond conventional behaviours to determine the extent to which behaviours—including sleep, physical activity, sedentary behaviour, sugary drink consumption, and fruit and vegetable intake—cluster in a national sample of New Zealand adults. Findings from this research will be used to inform lifestyle-based interventions targeting behaviours for optimal wellbeing.

Methods

Study design

Data were drawn from the Sovereign Wellbeing Index (Round 1), a cross-sectional study of wellbeing in New Zealand which has been described in detail elsewhere [5, 22]. Ethical approval to conduct the study was granted by the Auckland University of Technology Ethics Committee (AUTEC 12/201).

Participants

Participants were recruited from the largest commercial database in New Zealand. A total of 38,439 New Zealand adults (aged over 18 years) were invited via email to participate in a web-based wellbeing survey. The web-based survey utilised a point and click interface and included 134 questions on wellbeing, health and lifestyle, and socio-demographics. Data were collected between September 2012 and October 2012. All participants provided informed consent prior to entering the survey.

Measures

Measures specific to the current study only are described in detail below.

Lifestyle behaviours

Five lifestyle behaviours were selected for inclusion in this study; sleep, physical activity, sedentary behaviour, sugary drink consumption, and fruit and vegetable intake. Each lifestyle behaviour was dichotomised into healthy and unhealthy categories.

Sleep was measured using a single-item *(How much of the time during the past week did you experience restless sleep?)* drawn from the European Social Survey (Round 6) [23]. Similar to previous research, responses were dichotomised into healthy (experiencing restless sleep none/almost none of the time or some of the time) and unhealthy (experiencing restless sleep most or all/almost all of the time) categories [24, 25].

Physical activity and sedentary behaviour were measured using the Lifestyle Physical Activity and Sedentary Scale, an original scale developed for the Sovereign Wellbeing Index [26]. Physical activity was assessed using six items which took into account; lifestyle physical activity, active transport, and purposeful exercise. Responses were used to profile individuals' physical activity as very low, low, moderate, or high. Very low and low physical activity profiles were classified as unhealthy (i.e. falling substantially below or doing some activity but unlikely to be meeting the Ministry of Health's guidelines for physical activity); while moderate and high physical activity profiles were classified as healthy (i.e. meeting or exceeding the Ministry of Health's guidelines for physical activity) [27].

Sedentary scores were calculated using a single-item sitting question (*How much of the time during the past week did you spend sitting?*) from the Lifestyle Physical Activity and Sedentary Scale [5, 26]. Based on their responses, participants were classified as having very low (none/almost none of the time), low (a little of the time), moderate (some of the time), or high (most or all/almost all of the time) sedentary levels. There are currently no standardised thresholds for classifying unhealthy and healthy levels of sedentary behaviour. The following dichotomies were, therefore, utilised for this study: low and very low sedentary levels were classified as healthy; moderate and high sedentary levels were classified as unhealthy.

Sugary drink consumption was used as a proxy for sugar intake and was assessed using a single-item question *(How often during the past week did you drink sugary beverages?)* [28]. Respondents were instructed to include all energy drinks, carbonated drinks (i.e., fizzy drinks), fruit juice, and cordial (diet drinks were excluded). Current Ministry of Health guidelines were used to classify sugary drink consumption as healthy (< 1 time/week) and unhealthy (≥ 1 time/week) [27].

Fruit and vegetable intake were measured using two questions drawn from the New Zealand Health Survey [28]. The questions asked participants to report on average how many servings of fruit and vegetables they had each day over the past week. Current Ministry of Health guidelines were used to classify fruit and vegetable intake as healthy (≥ 2 servings of fruit and ≥ 3 servings of vegetables) or unhealthy (< 2 servings of fruit or < 3 servings of vegetables) [29].

Optimal wellbeing

Optimal wellbeing was treated as a binary variable and was calculated using a modified version of Huppert and So's flourishing scale [4, 30]. Ten items, originally drawn from the European Social Survey (Round 6) [31], were used to calculate optimal wellbeing. The ten items included measures of happiness, vitality, optimism, resilience, self-esteem, emotional stability engagement, meaning, optimism, and positive relationships [4]. These items combine both hedonic (feelings) and eudaimonic (functioning) aspects of wellbeing and were designed to mirror the internationally agreed criteria for depression and anxiety [4]. Items were rated on 4-point to 11-point Likert scales [30]. All items were phrased in a positive direction except for the item measuring resilience, which was reverse coded. Hone et al.'s [30] thresholds were used to calculate whether participants met the criteria for each item. Optimal wellbeing was determined as meeting the thresholds for positive emotion (happiness); and four out of five features of positive characteristics (vitality, optimism, resilience, self-esteem, emotional stability); and three out of four features of positive functioning (engagement, meaning, optimism, positive relationships) [30].

Data analysis

Multiple lifestyle behaviours and optimal wellbeing. Firstly, the prevalence of healthy and unhealthy dichotomies were calculated for each lifestyle behaviour. To determine whether engaging in multiple healthy lifestyle behaviours was associated with optimal wellbeing, the prevalence rates of the sample engaging in 0-5 healthy lifestyle behaviours were calculated. Binary logistic regression analyses (IBM SPSS Statistics version 19 for Windows) were used to calculate crude and adjusted (age, gender, ethnicity, and household income) odds ratios and 95% confidence intervals (CI) for being in the optimal wellbeing group. The alpha was set at $p<0.05$ to determine statistical significance.

Clustering. Clustering ratios (observed prevalence/expected prevalence), 95% CIs, and the prevalence of optimal wellbeing were calculated for all possible two-, three-, four-, and five-healthy and unhealthy behaviour combinations. The observed prevalence was calculated as the proportion of the sample in each behaviour combination examined in this study. The expected prevalence was calculated by multiplying the observed prevalence of the individual behaviours together (e.g. healthy sleep*healthy physical activity) [13]. These clustering ratios were used to determine whether lifestyle behaviours clustered or occurred independently in the sample. Ratios >1 indicated clustering (i.e. the observed prevalence is higher than the expected prevalence); ratios <1 indicated that the behaviours occurred independently [12, 32].

Results

Participant characteristics

In total, 9,962 New Zealand adults completed the survey. Participants were excluded from analysis if they were missing data from any of the five lifestyle behaviours (5%; n=537). Thus, valid data were available from 9,425 (47% male) participants. Table 1 provides a summary of the participant characteristics.

Table 1. Participant characteristics (n=9,425)

	n	%		n	%
Gender			**Household income tertile**		
Male	4415	47	≤ $40,000	2351	25
Female	4993	53	$40,001 - $90,000	2523	27
Missing	17	0.2	≥ $90,001	2204	23
			Missing	2347	25
Age			**Ethnicity**		
< 40 years	3513	37	European/other	7045	75
40 - 59 years	2740	29	Asian	987	11
≥ 60 years	1895	20	Maori/Pacific	1222	13
Missing	1277	14	Missing	171	2

Prevalence of individual behaviours

Of the total sample, 69% experienced healthy sleep, 58% had healthy levels of physical activity, 60% had healthy sedentary levels, 43% had a healthy consumption of sugary drinks, and 25% had a healthy fruit and vegetable intake.

Multiple lifestyle behaviours and optimal wellbeing

Overall, 5% of the sample reported not engaging in any healthy lifestyle behaviours and 5% reported engaging in all five healthy lifestyle behaviours over the past week (Figure 1).

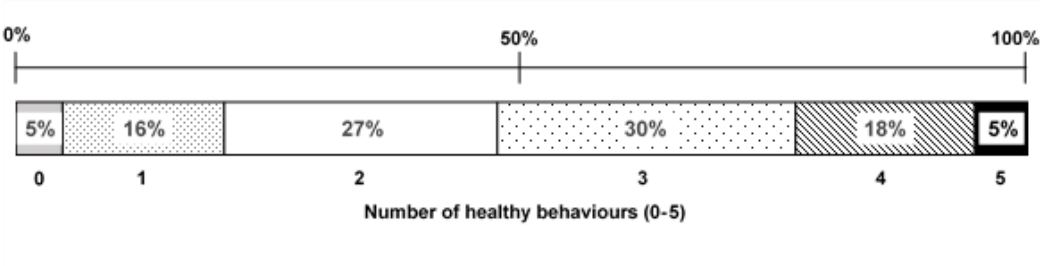

Figure 1. The proportion of the sample engaging in nil to five healthy lifestyle behaviours. Participants were asked to report on their engagement in five lifestyle behaviours (sleep, physical activity, sedentary behaviour, sugary drink consumption, and fruit and vegetable intake) over the past week.

Optimal wellbeing data were available for 9,235 participants. In total, 24% of the sample met the criteria for optimal wellbeing. Table 2 shows the prevalence of optimal wellbeing and the likelihood of being in the optimal wellbeing group based on the number of healthy lifestyle behaviours endorsed. The adjusted odds ratios show that those engaging in four or five healthy lifestyle behaviours were 4.7 (95% CI 3.8-5.7) times more likely to fall into the optimal wellbeing group compared to those engaging in 0-1 healthy lifestyle behaviours.

Table 2. Prevalence and likelihood of being in the optimal wellbeing group based on the number of healthy lifestyle behaviours endorsed (n=9,235).

	Non-optimal wellbeing n (%)	Optimal wellbeing n (%)	Crude odds ratio (95% CI[1])	Adjusted[2] odds ratio (95% CI)
Total	6979 (76)	2256 (24)		
0-1 healthy behaviour(s)	1697 (89)	213 (11)	Reference	Reference
2-3 healthy behaviours	4024 (77)	1177 (23)	2.3 (2.0-2.7)	2.2 (1.8-2.7)
4-5 healthy behaviours	1258 (59)	866 (41)	5.5 (4.6-6.5)	4.7 (3.8-5.7)

[1]Confidence interval

[2]Adjusted for age, gender, ethnicity, and household income

Clustering

Tables 3 and 4 show the clustering ratios, 95% CIs, and the prevalence of optimal wellbeing for two-, three-, four-, and five-lifestyle behaviour combination patterns.

Five-behaviour combinations. Clustering—indicated by a ratio >1.0—was observed for both the healthy and unhealthy five-behaviour combinations. The observed prevalence of having all five healthy (cluster ratio 2.0, 95% CI 1.8-2.2) or unhealthy (cluster ratio 2.1, 95% CI 1.9-2.3) behaviours was higher than could have been expected on the basis of the individual probabilities of the five behaviours alone. In total, 47% (95% CI 43-51) of people who met the guidelines for all five healthy behaviours were classified as having optimal levels of wellbeing. Conversely, 6% (95% CI 4-8) of the unhealthy group were classified as having optimal levels of wellbeing.

Four-behaviour combinations. Clustering was observed in all four-behaviour combinations. The greatest degree of clustering was observed between the healthy combination of sleep, physical activity, sedentary behaviour, and fruit and vegetable intake (2.1, 95% CI 2.0-2.3). In total, 10% of the sample met these four healthy behaviours and the prevalence of optimal wellbeing within this group was 44% (95% CI 40-47). Of the unhealthy behaviour combinations, the greatest degree of clustering was observed between sleep, physical activity, sedentary behaviour, and sugary drinks (1.8, 95% CI 1.6-1.9). For this group, the prevalence of optimal wellbeing was 6% (95% CI 4-8%).

Three-behaviour combinations. A degree of clustering was observed between all three-behaviour combinations; except the healthy combination of sleep, physical activity, and sugary drinks (1.1, 95% CI 1.0-1.1). Of the healthy behaviour combinations, the greatest degree of clustering was observed between physical activity, sedentary behaviour, and fruit and vegetable intake (1.4, 95% CI 1.3-1.5) and between physical activity, sugary drinks, and fruit and vegetable intake (1.4, 95% CI 1.3-1.4). For the unhealthy behaviours physical activity, sedentary behaviour, and sugary drink consumption (1.5, 95% CI 1.4-1.6); and physical activity, sedentary behaviour, and fruit and vegetable intake (1.5, 95% CI 1.4-1.6) showed the greatest degree of clustering.

Two-behaviour combinations. Most of the healthy and unhealthy two-behaviour patterns showed a degree of clustering. For the healthy lifestyle behaviours the greatest degree of clustering was observed between physical activity and sedentary behaviour (1.2, 95% CI 1.1-1.2); and between sugary drink consumption and fruit and

vegetable intake (1.2, 95% CI 1.1-1.2). A healthy fruit and vegetable consumption clustered with all behaviours (physical activity, sedentary behaviour, and sugary drinks), except sleep. For the unhealthy lifestyle behaviours only physical activity and sedentary behaviour clustered (1.4, 95% CI 1.3-1.4). At the two-behaviour level, sleep did not cluster with any other behaviour.

In summary, the greatest degree of clustering was observed between the healthy combination of sleep, physical activity, sedentary behaviour, and fruit and vegetable intake and the unhealthy combination of sleep, physical activity, sedentary behaviour, sugar drinks, and fruit and vegetable intake. The prevalence of optimal wellbeing was higher in the healthy behaviour combinations compared to the unhealthy behaviour combinations.

Table 3. Prevalence of combinations of healthy lifestyle behaviours

	Observed		Expected	Cluster ratio O/E[1] (95% CI)	Optimal wellbeing
	n	%	%		% (95% CI)
Individual behaviours					
Sleep	6526	69			31 (29-32)
Physical activity (PA)	5436	58			29 (27-30)
Sedentary behaviour (SB)	5635	60			29 (27-30)
Sugary drinks	4080	43			29 (28-30)
Fruit and vegetables (FV)	2389	25			33 (31-35)
Two-behaviour combinations					
Sleep*PA	3868	41	40	1.0 (1.0-1.1)	35 (34-37)
Sleep*SB	4026	43	41	1.0 (1.0-1.1)	35 (34-37)
Sleep*Sugary drinks	2923	31	30	1.0 (1.0-1.1)	36 (34-37)
Sleep*FV	1791	19	18	1.1 (1.0-1.1)	39 (37-41)
PA*SB	3849	41	34	1.2 (1.1-1.2)	31 (30-33)
PA*Sugary drinks	2390	25	25	1.0 (1.0-1.1)	33 (32-35)
PA*FV	1572	17	15	1.1 (1.1-1.2)	36 (34-39)
SB*Sugary drinks	2578	27	26	1.1 (1.0-1.1)	33 (31-35)
SB*FV	1602	17	15	1.1 (1.1-1.2)	37 (34-39)
Sugary drinks*FV	1220	13	11	1.2 (1.1-1.2)	37 (34-40)
Three-behaviour combinations					
Sleep*PA*SB	2761	29	24	1.2 (1.2-1.3)	38 (36-40)
Sleep*PA*Sugary drinks	1775	19	17	1.1 (1.0-1.1)	40 (38-42)
Sleep*PA*FV	1201	13	10	1.3 (1.2-1.3)	41 (39-44)
Sleep*SB*Sugary drinks	1916	20	18	1.1 (1.1-1.2)	40 (38-42)
Sleep*SB*FV	1245	13	10	1.3 (1.2-1.3)	42 (39-45)
Sleep*Sugary drinks*FV	945	10	8	1.3 (1.2-1.4)	43 (40-46)
PA*SB*Sugary drinks	1738	18	15	1.2 (1.2-1.3)	36 (34-38)
PA*SB*FV	1169	12	9	1.4 (1.3-1.5)	39 (36-41)
PA*Sugary drinks*FV	806	9	6	1.4 (1.3-1.4)	40 (37-44)
SB*Sugary drinks*FV	830	9	7	1.3 (1.3-1.4)	41 (38-45)
Four-behaviour combinations					
Sleep*PA*SB*Sugary drinks	1308	14	10	1.3 (1.3-1.4)	42 (40-45)
Sleep*PA*SB*FV	911	10	5	2.1 (2.0-2.3)	44 (40-47)
Sleep*PA*Sugary drinks*FV	643	7	4	1.6 (1.4-1.7)	45 (41-49)
Sleep*SB*Sugary drinks*FV	669	7	5	1.6 (1.4-1.7)	46 (42-50)
PA*SB*Sugary drinks*FV	608	6	4	1.7 (1.6-1.8)	43 (39-47)
Five-behaviour combination					
Sleep*PA*SB*Sugary drinks*FV	495	5	3	2.0 (1.8-2.2)	47 (43-51)

[1]Observed prevalence/expected prevalence

Table 4. Prevalence of combinations of unhealthy lifestyle behaviours

	Observed		Expected	Cluster ratio O/E[1] (95% CI)	Optimal wellbeing
	n	%	%		% (95% CI)
Individual behaviours					
Sleep	2899	31			11 (9-12)
Physical activity (PA)	3989	42			19 (17-20)
Sedentary behaviour (SB)	3790	40			18 (17-20)
Sugary drinks	5345	57			21 (20-22)
Fruit and vegetables (FV)	7036	75			21 (21-22)
Two-behaviour combinations					
Sleep*PA	1331	14	13	1.1 (1.0-1.1)	8 (6-9)
Sleep*SB	1290	14	12	1.1 (1.0-1.2)	9 (7-10)
Sleep*Sugary drinks	1742	18	17	1.1 (1.0-1.1)	10 (8-11)
Sleep*FV	2301	24	23	1.1 (1.0-1.1)	9 (8-10)
PA*SB	2203	23	17	1.4 (1.3-1.4)	15 (14-17)
PA*Sugary drinks	2299	24	24	1.0 (1.0-1.1)	16 (14-17)
PA*FV	3172	34	32	1.1 (1.0-1.1)	16 (15-18)
SB*Sugary drinks	2288	24	23	1.1 (1.0-1.1)	16 (15-18)
SB*FV	3003	32	30	1.1 (1.0-1.1)	16 (15-18)
Sugary drinks*FV	4176	44	42	1.0 (1.0-1.1)	19 (18-20)
Three-behaviour combinations					
Sleep*PA*SB	810	9	5	1.6 (1.5-1.8)	7 (5-9)
Sleep*PA*Sugary drinks	789	8	7	1.1 (1.1-1.2)	7 (5-9)
Sleep*PA*FV	1104	12	10	1.2 (1.1-1.3)	7 (6-9)
Sleep*SB*Sugary drinks	795	8	7	1.2 (1.1-1.3)	8 (6-10)
Sleep*SB*FV	1049	11	9	1.2 (1.1-1.3)	8 (6-10)
Sleep*Sugary drinks*FV	1419	15	13	1.2 (1.1-1.2)	8 (7-10)
PA*SB*Sugary drinks	1353	14	10	1.5 (1.4-1.6)	13 (12-15)
PA*SB*FV	1819	19	13	1.5 (1.4-1.6)	14 (12-15)
PA*Sugary drinks*FV	1896	20	18	1.1 (1.1-1.2)	14 (13-16)
SB*Sugary drinks*FV	1891	20	17	1.2 (1.1-1.2)	15 (13-16)
Four-behaviour combinations					
Sleep*PA*SB*Sugary drinks	500	5	3	1.8 (1.6-1.9)	6 (4-8)
Sleep*PA*SB*FV	682	7	5	1.4 (1.3-1.5)	7 (5-9)
Sleep*PA*Sugary drinks*FV	674	7	6	1.3 (1.2-1.4)	7 (5-9)
Sleep*SB*Sugary drinks*FV	668	7	5	1.4 (1.3-1.5)	7 (5-9)
PA*SB*Sugary drinks*FV	1161	12	7	1.7 (1.6-1.8)	13 (11-15)
Five-behaviour combination					
Sleep*PA*SB*Sugary drinks*FV	436	5	2	2.1 (1.9-2.3)	6 (4-8)

[1]Observed prevalence/expected prevalence

Discussion

The first aim of this study was to determine the association between multiple lifestyle behaviours and optimal wellbeing in a national sample of New Zealand adults. The results showed a positive association between the number of healthy lifestyle behaviours endorsed and the likelihood of achieving the criteria for optimal wellbeing. Those engaging in four or five healthy lifestyle behaviours were 4.7 (95% CI 3.8-5.7) times more likely to achieve the criteria for optimal wellbeing compared to those engaging in none or one healthy lifestyle behaviour. The second aim of this study was to investigate the extent to which five lifestyle behaviours—sleep, physical activity, sedentary behaviour, sugary drink consumption, and fruit and vegetable intake—clustered. In this study, clustering was observed for healthy and unhealthy five-, four- and three-behaviour combinations, though the extent to which the behaviours clustered varied. Evidence of clustering was less consistent for the two-behaviour combinations.

The findings from this study indicate engaging in multiple lifestyle behaviours may have a synergistic effect on optimal wellbeing. We show the likelihood of achieving optimal wellbeing increases with the number of healthy lifestyle behaviours endorsed. Nearly 50% of the group engaging in all five healthy behaviours met the criteria for optimal wellbeing, compared to just 6% of those engaging in no healthy lifestyle behaviours. Our results are consistent with previous research which has shown that engaging in fewer *health risk* behaviours is associated with increased satisfaction with life [3]. It was, therefore, concerning to find only 5% of the sample engaged in all five healthy lifestyle behaviours. Similar low prevalence rates (3-8%) for meeting multiple healthy lifestyle behaviours have been reported elsewhere [13, 14, 17].

Although causation cannot be inferred from our data, findings from intervention studies provide evidence to suggest improvements in isolated behaviours result in improved wellbeing outcomes [33]. Findings from a recent study, for example, show participation in a 4-week fitness programme had a significant and positive effect on satisfaction with life [33]. There is also emerging research to suggest the positive effect of multiple healthy lifestyle behaviours on optimal wellbeing is biologically plausible [34]. Engaging in healthy lifestyle behaviours enhances neuroplasticity by reducing inflammation and increasing the expression of brain-derived neurotrophic growth factor [35, 36]. Research shows neuroplasticity is essential for many of the dimensions underpinning optimal wellbeing such as creativity, exploration, and curiosity [7, 34]. Engaging in a combination of healthy behaviours which cause an overall reduction in inflammation and enhancement in brain-derived neurotrophic growth factor is, therefore, likely to have positive implications for wellbeing.

International research provides compelling evidence to support the clustering of lifestyle behaviours [16]. Previous studies show lifestyle behaviours cluster at both ends of the unhealthy-healthy spectrum, with more people than expected engaging in all unhealthy behaviours or all healthy behaviours [14, 16, 37]. Despite the inclusion of different lifestyle behaviours—including sugary drink consumption, sedentary behaviour, and sleep—the results of the current study are consistent with this international research showing clustering at both ends of the spectrum. Nonetheless, the results from the current study contrast previous national research which has provided little evidence to support the clustering of lifestyle behaviours in New Zealand [12, 13]. These differences may be attributed to the number and type of lifestyle behaviours included, the use of a homogenous sample [13], or the exclusion of people diagnosed with cardiovascular disease or cancer [12].

To our knowledge the current study is the first to examine the extent to which sleep, physical activity, sedentary behaviour, sugary drink consumption, and fruit and vegetable intake cluster. It was interesting to note that the healthy combination of sleep, physical activity, and sugary drink consumption was the only three-behaviour combination which did not cluster (1.1, 95% CI 1.0-1.1). Furthermore, at the two-behaviour level, sleep did not cluster with any other behaviour, though it clustered at the three-, four- and five-behaviour level. In contrast, physical activity and sedentary behaviour clustered to the greatest degree, particularly for the unhealthy combination (1.4, 95% CI 1.3-1.4). Although these two behaviours are each independently associated with health [18] and wellbeing [5, 21] the current study indicates they occur among the same people in the population suggesting both behaviours should be targeted in interventions. It was also interesting to find that, for healthy behaviours, the greatest degree of clustering was not observed between all five behaviours. Rather, the four-behaviour combination of sleep, physical activity, sedentary behaviour, and fruit and vegetable intake showed a greater degree of clustering. Based on these results, multi-dimensional lifestyle interventions should target all five behaviours; though increased emphasis should be placed on increasing physical activity, minimising sedentary behaviour, improving sleep, and consuming fruit and vegetables.

Due to the cross-sectional design of clustering studies it is difficult to determine why lifestyle behaviours cluster together, especially at the unhealthy and healthy ends of the spectrum. Clustering may partly be explained by social and environmental factors [38]. There is, however, some evidence to suggest the clustering of lifestyle behaviours may be influenced by a behaviour-biochemistry feedback loop [39]. For example, several researchers have demonstrated a negative behaviour-biochemistry feedback loop in their research [39-42]. They show chronically raised insulin resulting from poor lifestyle choices—such as a poor quality diet, sedentary behaviour, and poor sleep—blocks leptin signalling to the hypothalamus. As leptin is an energy regulating hormone, the body's ability to regulate energy is impaired. This results in the body initiating an adaptive response to "starvation"; individuals will feel like eating more and moving less, despite having consumed calories in excess [41]. It is plausible a similar positive feedback loop may exist.

The evidence to support clustering in the present study raises the possibility of employing multiple behaviour change interventions to enhance wellbeing. There is currently a small, but growing, body of work in which the utility of multiple behaviour change interventions have been explored [43]. Several benefits of multiple behaviour change interventions have been identified at both the individual- and population- levels [9]. For individuals, successfully improving one or more lifestyle behaviours may lead to the confidence and self-efficacy to improve others [9]. At the population level, there is evidence to suggest that targeting multiple behaviours concurrently is likely to be both efficient and cost-effective [9]. An intervention targeting the five behaviours we examined, for instance, would have relevance to 95% of our sample as only 5% of our sample engaged in all five healthy lifestyle behaviours. Conversely, an intervention focusing on just physical activity would only have relevance to the 48% of the sample not engaging in the behaviour. Given the potential benefits, further research investigating the use of multiple behaviour change interventions for improving wellbeing outcomes is warranted.

Strengths of this study include the use of a large heterogeneous sample which represents New Zealand adults across a range of age, income, and ethnic demographics. Limitations of the study includes the cross-sectional design, which precludes the ability to infer causation. Further, the web-based recruitment strategy may also be

considered a source of bias. However, findings from a review paper show the age, gender, income, education, and health status of subjects responding to a web-based survey are comparable to those responding to traditional modes of data collection [44]. Notwithstanding the study's limitations, this research shows diverse behaviours including sleep, sedentary behaviour, and to a lesser degree sugary drink consumption cluster with physical activity and fruit and vegetable intake. Furthermore, this research advances both the public health and positive psychology literature to show, for the first time, that lifestyle behaviours associated with optimal wellbeing cluster.

Conclusion

This research has shown there is a positive association between the number of healthy lifestyle behaviours endorsed and optimal wellbeing. Furthermore, the findings support the notion that lifestyle behaviours cluster at both ends of the healthy- and unhealthy-spectrum. These results suggest further research investigating the use of multiple behaviour change interventions for improving levels of optimal wellbeing is warranted.

Funding

This study was funded by Sovereign. KP was supported by a Sovereign Wellbeing Index Doctoral Scholarship.

Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

References

1. Seligman M. Positive health. Appl Psych Meas. 2008;57(S1):3-18. doi:10.1111/j.1464-0597.2008.00351.x

2. Vazquez C, Hervas G, Rahona J, Gomez D. Psychological well-being and health: contributions of positive psychology. Annuary of Clinical and Health Psychology. 2009;5:15-27.

3. Evers KE, Castle PH, Prochaska JO, Prochaska JM. Examining relationships between multiple health risk behaviors, well-being, and productivity. Psychol. Rep. 2014;114(3):843-53. doi:10.2466/13.01.PR0.114k25w4

4. Huppert F, So TC. Flourishing across Europe: application of a new conceptual framework for defining well-being. Soc. Indic. Res. 2013;110(3):837-61. doi:10.1007/s11205-011-9966-7

5. Prendergast KB, Schofield GM, Mackay LM. Associations between lifestyle behaviours and optimal wellbeing in a diverse sample of New Zealand adults. BMC Public Health. 2016;16(1). doi:10.1186/s12889-016-2755-0

6. Walsh R. Lifestyle and mental health. Am. Psychol. 2011;66(7):579-92.
7. Conner TS, Brookie KL, Richardson AC, Polak MA. On carrots and curiosity: eating fruit and vegetables is associated with greater flourishing in daily life. Br. J. Health Psychol. 2015 doi:10.1111/bjhp.12113.
8. Conry MC, Morgan K, Curry P, et al. The clustering of health behaviours in Ireland and their relationship with mental health, self-rated health and quality of life. BMC Public Health. 2011. doi:10.1186/1471-2458-11-692
9. Prochaska JJ, Spring B, Nigg CR. Multiple health behavior change research: An introduction and overview. Prev. Med. 2008;46(3):181-8. doi:10.1016/j.ypmed.2008.02.001
10. McAloney K, Graham H, Law C, Platt L. A scoping review of statistical approaches to the analysis of multiple health-related behaviours. Prev. Med. 2013;56(6):365-71. doi:10.1016/j.ypmed.2013.03.002
11. Pronk NP, Anderson LH, Crain AL, et al. Meeting recommendations for multiple healthy lifestyle factors: prevalence, clustering, and predictors among adolescent, adult, and senior health plan members. Am. J. Prev. Med. 2004;27(2 Suppl):25-33. doi:10.1016/j.amepre.2004.04.022
12. Tobias M, Jackson G, Yeh L-C, Huang K. Do healthy and unhealthy behaviours cluster in New Zealand? Aust. N. Z. J. Public Health. 2007;31(2):155-63. doi:10.1111/j.1753-6405.2007.00034.x
13. Williden M, Duncan S, Schofield G. Do health behaviours cluster in a working population in New Zealand? Health Promot. J. Austr. 2012;23(3):234-6.
14. Poortinga W. The prevalence and clustering of four major lifestyle risk factors in an English adult population. Prev. Med. 2007;44(2):124-8. doi:10.1016/j.ypmed.2006.10.006
15. Baruth M, Addy C, Wilcox S, Dowda M. Clustering of risk behaviours among African American adults. Health Educ. J. 2011;71(5):565-75. doi:10.1177/0017896911411761
16. Berrigan D, Dodd K, Troiano RP, Krebs-Smith SM, Barbash RB. Patterns of health behavior in U.S. adults. Prev. Med. 2003;36(5):615-23. doi:10.1016/s0091-7435(02)00067-1
17. French S, Rosenberg M, Knuiman M. The clustering of health behaviours in a Western Australian adult population. Health Promot. J. Austr. 2008;19(3):203-9.
18. Helmerhorst HJF, Wijndaele K, Brage S, Wareham NJ, Ekelund U. Objectively measured sedentary time may predict insulin resistance independent of moderate- and vigorous-intensity physical activity. Diabetes. 2009;58(8):1776-9.
19. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. Sleep. 2010;33(5):585-92.
20. Brown CM, Dulloo AG, Montani JP. Sugary drinks in the pathogenesis of obesity and cardiovascular diseases. Int. J. Obes. 2008;32 (S6):S28-34. doi:10.1038/ijo.2008.204
21. Atkin A, Adams E, Bull F, Biddle S. Non-occupational sitting and mental well-being in employed adults. Ann. Behav. Med. 2012;43(2):181-8. doi:10.1007/s12160-011-9320-y
22. Jarden A, Mackay L, White K, et al. The Sovereign New Zealand Wellbeing Index. Psychology Aotearoa. 2013;5(1):22-7.
23. European Social Survey. ESS Round 3 source questionnaire. London: Centre for Comparative Social Surveys, City University London2006.

24. Kutner NG, Bliwise DL, Zhang R. Linking race and well-being within a biopsychosocial framework: variation in subjective sleep quality in two racially diverse older adult samples. J. Health Soc. Behav. 2004;45(1):99-113.
25. Burgard SA, Ailshire JA. Putting work to bed: stressful experiences on the job and sleep quality. J. Health Soc. Behav. 2009;50(4):476-92.
26. Hone LC, Jarden A, Duncan S, Schofield GM. Flourishing in New Zealand Workers: Associations With Lifestyle Behaviors, Physical Health, Psychosocial, and Work-Related Indicators. J. Occup. Environ. Med. 2015;57(9):973-83. doi:10.1097/JOM.0000000000000508
27. Ministry of Health. Eating and activity guidelines for New Zealand adults. 2015.
28. Ministry of Health. 2006/07 New Zealand health survey: adult questionnaire. Wellington: Ministry of Health2006.
29. Ministry of Health. New Zealand health strategy. Wellington: Ministry of Health2000.
30. Hone L, Jarden A, Schofield G. Measuring flourishing: the impact of operational definitions on the prevalence of high levels of wellbeing. IJW. 2014;4(1):62-90. doi:10.5502/ijw.v4i1.4
31. European Social Survey. ESS Round 6 source questionnaire. London: Centre for Comparative Social Surveys, City University2012.
32. Ebrahim S, Montaner D, Lawlor DA. Clustering of risk factors and social class in childhood and adulthood in British women's heart and health study: cross sectional analysis. Br. Med. J. 2004. doi:10.1136/bmj.38034.702836.55
33. Wicker P, Coates D, Breuer C. The effect of a four-week fitness program on satisfaction with health and life. International journal of public health. 2015;60(1):41-7. doi:10.1007/s00038-014-0601-7
34. Gomez-Pinilla F. The influences of diet and exercise on mental health through hormesis. Ageing Res Rev. 2008;7(1):49-62. doi:10.1016/j.arr.2007.04.003
35. Rothman SM, Mattson MP. Activity-dependent, stress-responsive BDNF signaling and the quest for optimal brain health and resilience throughout the lifespan. Neuroscience. 2013;239(0):228-40. doi:10.1016/j.neuroscience.2012.10.014
36. Mattson MP. Dietary factors, hormesis and health. Ageing Res Rev. 2008;7(1):43-8. doi:10.1016/j.arr.2007.08.004
37. Laaksonen M, Prattala R, Karisto A. Patterns of unhealthy behaviour in Finland. Eur. J. Public Health. 2001;11(3):294-300.
38. Spring B, Moller AC, Coons MJ. Multiple health behaviours: overview and implications. Journal of public health. 2012;34(S1):S3-10. doi:10.1093/pubmed/fdr111
39. Lustig RH. Which comes first? The obesity or the insulin? The behavior or the biochemistry? The Journal of Pediatrics. 2008;152(5):601-2. doi:10.1016/j.jpeds.2008.01.021
40. Mark AL, Rahmouni K, Correia M, Haynes WG. A leptin-sympathetic-leptin feedback loop: potential implications for regulation of arterial pressure and body fat. Acta Physiol. Scand. 2003;177(3):345-9. doi:10.1046/j.1365-201X.2003.01085.x
41. Isganaitis E, Lustig RH. Fast food, central nervous system insulin resistance, and obesity. Arterioscler. Thromb. Vasc. Biol. 2005;25(12):2451-62. doi:10.1161/01.ATV.0000186208.06964.91

42. Lustig RH, Sen S, Soberman JE, Velasquez-Mieyer PA. Obesity, leptin resistance, and the effects of insulin reduction. Int. J. Obes. Relat. Metab. Disord. 2004;28(10):1344-8. doi:10.1038/sj.ijo.0802753

43. Prochaska JJ, Prochaska JO. A review of multiple health behavior change interventions for primary prevention. Am. J. Lifestyle Med. 2011;5(3):208-21. doi:10.1177/1559827610391883

44. van Gelder MM, Bretveld RW, Roeleveld N. Web-based questionnaires: the future in epidemiology? Am. J. Epidemiol. 2010 doi:10.1093/aje/kwq291.