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Supporting Information

Supplementary methods and results

Appendix to: O'Dean S, Sunderland M, Newton N, et al. The Health4Life e-health intervention for modifying lifestyle risk behaviours of adolescents: secondary outcomes of a cluster randomised controlled trial. *Med J Aust* 2024; doi: 10.5694/mja2.52279.

1. Supplementary methods: outcomes

Tobacco smoking frequency: Assessed by one item, ***'****During the past 30 days, how many days did you smoke cigarettes?*'. Response categories were: 0, 1 or 2, 3-5, 6-9, 10-19, 20-29, and all 30 days. The smoking frequency variable was recoded to mid-points (e.g., 1-2 days was coded as 1.5; 3-5 days was coded as 4) to give a numerical indication of number of days in the last 30 days participants had smoked, ranging from 0 days to 30.

Alcohol consumption frequency: Assessed by one question: '*How often did you have a standard alcoholic drink of any kind in the past 6 months?'*. Response categories were: never, less than monthly, once a month, 2-3 times a month, weekly, and daily or almost daily. The derived drinking frequency variable was recoded to the midpoint of each response category to give an indication of mean number of days per month spent drinking alcohol (e.g., once a month was coded as 1; weekly was coded as 4; daily or almost daily was coded as 28).

Binge drinking. Assessed by one question accompanied by a standard drink pictorial chart; *'How <u>often</u> did you have <u>5 or more</u> standard alcoholic drinks on one occasion <u>in the past 6 months</u>?*'. Response categories ranged from 'never' to 'daily or almost daily'. The derived binge drinking variable was recoded to a binary variable (0 = never, 1 = any).

Alcohol-related harms. Students who report drinking alcohol in the past 6 months completed the Abbreviated Rutgers Alcohol Problem Index[(1)]. Students rated 9 items about the number of times they had experienced any of the consequences of drinking alcohol on a scale of 0 = 'never' to 4 = 'more than 6 times'. Example items include '*Got into fights, acted bad, or did mean things*', and '*Neglected my responsibilities*'. Items were summed to give a total score ranging from 0 to 36.

Discretionary food risk. The derived discretionary food risk variable was binary (0 = not at risk, 1 = at risk) and indicated whether students consumed more than 1 discretionary food item per day (e.g., hot chips, biscuits, cakes, confectionary, ice cream, fast-food take-away meals).

Fruit intake: A single item accompanied by a standard fruit serve pictorial chart assessed usual number of serves of fruit each day. The derived vegetable intake variable was coded as binary where 0 = meets guidelines (i.e., 2 or more serves per day), and 1 = does not meet guidelines (i.e., less than 2 serves per day)[(2)].

Vegetable intake: A single item accompanied by a standard vegetable serve pictorial chart assessed usual number of serves of vegetables each day. The derived vegetable intake variable was coded as binary where 0 = meets guidelines (i.e., 5 or more serves per day), and 1 = does not meet guidelines (i.e., less than 5 serves per day)[(2)].

Light physical activity. A single item measured the times in the past week students' engaged in at least 10 minutes of light (i.e., walking continuously)[3] and responses were coded as 0 = 0 times, 1 = 1-2 times, 3 = 3-4 times, and 5 = 5 or more times[4].

Daytime sleepiness: The Paediatric Daytime Sleepiness Scale[5] measured daytime sleepiness and its associated school outcomes. There were 8 items, each scored on a scale from 0 = 'never' to 4 = 'very often/always'. Example items include '*How often do you fall asleep of feel drowsy in class*' and '*How often are you tired and grumpy during the day?*'. All items were summed to give a total score out ranging from 0 to 32.

Sleep difficulty: Assessed with one binary response item, *'Do you have difficulty falling asleep?'* (0 = no, 1 = yes).

Daily recreational screen time: Secondary screen time outcomes were mean daily recreational hours spent (1) watching television or streaming platforms and (2) on electronic devices (e.g., computers, smartphones, Xbox, etc.). The derived variables were weighted means of daily screen time weekdays and weekend days.

2. Supplementary methods: statistical analysis model types

Logistic latent growth models: To investigate the efficacy of the *Health4Life* intervention on likelihood of binge drinking, not meeting fruit, vegetable and discretionary food guidelines, and sleep difficulty, we used a random effects latent growth model (LGM) fit to binary data. Intervention status regressed on the intercept represents the difference in the log odds of the outcome at baseline for intervention group compared to control group. Whereas intervention status regressed on the slope latent factor reflects the relative difference in log odds at the 24-month occasion (in the case of the free time score model, 12 months in the case of linear or quadradic) of the outcome for the intervention group compared to control, adjusted for baseline differences. Log-odds were exponentiated to odds ratios for ease of interpretation.

Ordinal latent growth models: Ordinal logistic regression was used to investigate whether the *Health4Life* intervention was effective at increasing the likelihood of engaging in more frequent light physical activity. Intervention status regressed on the latent intercept parameter represent the difference in log odds of being in a higher activity category between the groups at baseline. Intervention status regressed on slope parameter reflects the relative differences in log odds at the 12-month (linear and quadradic time score models) or 24-month occasion (in the case of the free time score model) of being in a higher activity category for the intervention group compared to control, adjusted for baseline differences. Log-odds were exponentiated to odds ratios for ease of interpretation.

Continuous latent growth models: Continuous latent growth models investigated the effects of the Health4Life intervention on the continuous variables (i.e., alcohol harms and frequency, tobacco smoking frequency, daytime sleepiness, and mean daily hours spent watching tv and on electronic devices). The intervention regressed on the intercept represents the mean score of the outcome at baseline in the intervention group compared to control. The intervention regressed on slope estimates tell us the relative difference in the mean growth of the outcome over 12 months (for linear and quadradic time score models) or 24 months (for free-time score models) for the intervention group compared to the control group, adjusted for baseline. Estimates reported for these models are model estimated mean differences.

3. Supplementary methods: statistical analyses, model fit

We tested different specifications of time scores (linear, quadradic and freely estimated) on unconditional LGMs (i.e., no covariates) to determine the best fitting time structure and slope estimate interpretation for each outcome. In this case, linear models indicate that the slope reflects a change in the outcome over a 1-year interval, quadratic time scores indicate that the 1-year change in outcomes accelerates or decelerates at each interval (depending on the function of the quadratic term), and free time scores indicate that the slope reflects the overall change from baseline to 24-month follow up, allowing the data to account for any non-linear growth occurring at post-intervention and 12-month occasions (i.e., baseline time is fixed at 0, and 24-months at 1, but timepoints in-between are free).

That is, slope parameter estimates differ in their interpretation for linear and freely scored models such that linear and quadradic time score models represent a 1-year change, and free time score models represent a 24-month change.

The best fitting time scores (by way of Akaike information criterion (AIC), Bayesian information criterion (BIC) and sample size adjusted (ssaBIC)) varied substantially between outcomes, with four outcomes being best fit by each linear, quadradic and freely estimated time scores. Model fit statistics for the best fitting unconditional growth models, and their type of time scores are reported in table 5. In the case that linear or quadradic time score models were the best fit for the data, we report 24-month parameter estimates (i.e., slope × 2) for ease of interpretation of outcomes of the conditional growth models.

Table 1. Baseline socio-demographic characteristics of the Health4Life participants

Characteristic	Total	Intervention arm	Control arm
All participants		3610	3030
Gender			
Boys	3311 (49.8%)	1865 (51.7%)	1446 (47.7%)
Girls	3204 (48.3%)	1683 (46.6%)	1521 (50.2%)
Non-binary/gender-fluid	30 (0.4%)	14 (0.4%)	16 (0.5%)
No response/missing	95 (1.4%)	48 (1.3%)	47 (1.6%)
Age (years)			
11	9 (0.1%)	5 (0.1%)	4 (0.1%)
12	2365 (35.6%)	1249 (34.6%)	1116 (36.8%)
13	4158 (62.6%)	2303 (63.8%)	1855 (61.2%)
14	71 (1.1%)	39 (1.1%)	32 (1.1%)
No response/missing	37 (0.6%)	14 (0.4%)	23 (0.8%)
State			
New South Wales (37 schools)	3536 (53.3%)	2041 (56.5%)	1495 (49.3%)
Queensland (18 schools)	1789 (26.9%)	1134 (31.4%)	655 (21.6%)
Western Australia (16 schools)	1315 (19.8%)	435 (12.0%)	880 (29.0%)
School type			
Government (24 schools)	2003 (30.2%)	1135 (31.4%)	868 (28.6%)
Independent (37 schools)	3378 (50.9%)	1485 (41.1%)	1893 (62.5%)
Catholic (10 schools)	1259 (18.9%)	990 (27.4%)	269 (8.9%)
Geographic remoteness*			
Major city (60 schools)	5954 (89.7%)	3304 (91.5%)	2650 (87.5%)
Inner or outer regional (11 schools)	686 (10.3%)	306 (8.5%)	380 (12.5%)
Socio-economic status†			
Lower	909 (13.7%)	558 (15.5%)	351 (11.6%)
Middle	2209 (33.3%)	1204 (33.4%)	1005 (33.2%)
Upper	2897 (43.6%)	1561 (43.2%)	1336 (44.1%)
No response/missing data	625 (9.4%)	287 (7.9%)	338 (11.1%)

* Australian Statistical Geography Standard.[6]

† Family Affluence Scale (FAS)III.[7] Scores were converted to ridit scores that compared socio-economic status with other people in study sample, and classified as low (ridit < 0.2), middle (ridit, 0.2–5.9), or upper socio-economic status (ridit, 0.6–1.0).

Table 2. Secondary outcomes at baseline, by completion of subsequent surveys: categorical outcomes

Behaviour	No follow-up survey completed	At least one follow-up survey completed	Odds ratio (95% CI) (at least one *v* no follow-up)
Binge drinking*	**291**	**6348**	
	1 (0.6%)	31 (0.5%)	1.19 (0.25–21.3)
Discretionary food risk*	**446**	**6193**	
	129 (44.6%)	2228 (41.0%)	0.86 (0.68–1.09)
Fruit intake inadequate*	**311**	**6328**	
	79 (33.5%)	1413 (23.8%)	0.62 (0.47–0.82)
Vegetable intake inadequate*	**311**	**6328**	
	214 (87.3%)	5148 (86.2%)	0.91 (0.61–1.31)
Light physical activity (per week)†	**313**	**6326**	
0 times	9 (3.7%)	272 (4.5%)	1
1-2 times	30 (12.2%)	740 (12.3%)	0.82 (0.38–1.74)
3-4 times	45 (18.3%)	1125 (18.7%)	0.83 (0.40–1.71)
5 or more times	162 (65.9%)	3873 (64.4%)	0.79 (0.40–1.57)
Sleep difficulty*	**226**	**6413**	
	106 (52.0%)	3895 (61.5%)	1.47 (1.11–1.95)

CI = confidence interval.
* Binary logistic regression. Bold: number of respondents.
† Multinomial logistic regression. Bold: number of respondents.

Table 3. Secondary outcomes at baseline, by completion of subsequent surveys: continuous outcomes

Behaviour	No follow-up survey completed	At least one follow-up survey completed	*t* value (df)	*P*
Tobacco use frequency (number of days in past 30 days), mean (SD)	**305**	**6334**		
	0.01 (0.12)	0.06 (1.22)	*t*(6277) = -0.69	0.60
Alcohol use frequency (number of days in past 30 days), mean (SD)	**286**	**6353**		
	0.07 (0.32)	0.05 (0.90)	*t*(6343) = 0.33	0.74
Alcohol harms,* mean (SD)	**1541**	**5098**		
	6.04 (6.41)	5.31 (6.18)	*t*(1884) = -2.43	0.015
Daytime sleepiness,† mean (SD)	**200**	**6439**		
	15.6 (6.44)	13.8 (6.11)	*t*(6594) = 3.81	<0.001
Television time (hours per day), mean (SD)	**253**	**6386**		
	3.53 (3.46)	2.71 (2.65)	*t*(6483) = 4.46	<0.001
Device use time (hours per day), mean (SD)	**253**	**6386**		
	3.84 (3.61)	3.14 (2.97)	*t*(6476) = 3.44	<0.001

df = degrees of freedom; SD = standard deviation.
* Abbreviated Rutgers Alcohol Problem Index.[(1)] Bold: number of respondents.
† Paediatric Daytime Sleepiness Scale.[(5)] Bold: number of respondents.

Table 4. Attrition analyses for secondary outcomes (ie, likelihood of no follow-up data)

Behaviour	Control	Health4Life	Odds ratio (95% CI)
Binge drinking			
No follow-up	118	173	
At least one follow-up	2912	3436	0.80 (0.63–1.02)
Discretionary food risk			
No follow-up	172	274	
At least one follow-up	2858	3335	0.73 (0.60–0.89)
Fruit guidelines			
No follow-up	117	194	
At least one follow-up	2913	3415	0.71 (0.56–0.89)
Vegetable guidelines			
No follow-up	116	195	
At least one follow-up	2914	3414	0.70 (0.55–0.88)
Light physical activity			
No follow-up	130	183	
At least one follow-up	2900	3426	0.84 (0.67–1.06)
Sleep difficulty			
No follow-up	94	132	
At least one follow-up	2936	3477	0.84 (0.64–1.10)
Tobacco use frequency			
No follow-up	123	182	
At least one follow-up	2907	3427	0.80 (0.63–1.01)
Alcohol use frequency			
No follow-up	117	169	
At least one follow-up	2913	3440	0.82 (0.64–1.04)
Alcohol harms			
No follow-up	82	118	
At least one follow-up	2948	3491	0.91 (0.81–1.02)
Daytime sleepiness			
No follow-up	82	118	
At least one follow-up	2948	3491	0.82 (0.62–1.09)
Television time			
No follow-up	103	150	
At least one follow-up	2927	3459	0.81 (0.63–1.05)
Electronic device time			
No follow-up	102	151	
At least one follow-up	2928	3458	0.80 (0.62–1.03)

CI = confidence interval.

Table 5. Summary of model fit estimates for the best fitting unconditional growth models

Model	AIC	BIC	ssaBIC	Time score
Light physical activity	42149.54	42197.08	42174.831	Linear
Television time	106985.445	107046.6	107018.01	Linear
Device time	109702.496	109777.2	109742.29	Free
Sleep difficulty	25116.087	25163.67	25141.424	Free
Daytime sleepiness	138249.946	138317.9	138286.16	Quadradic
Binge drinking	4156.196	4203.742	4181.498	Free
Alcohol use frequency	86124.285	86212.58	86171.273	Quadradic
Alcohol harms	25764.686	25817.82	25789.22	Quadradic
Tobacco use frequency	91917.312	91005.58	90964.265	Quadradic
Fruit guidelines	4749.452	4783.4	4767.511	Linear
Vegetable guidelines	3995.297	4029.251	4013.362	Linear
Discretionary food risk	24142.705	24190.14	24167.899	Free

AIC = Akaike information criterion. BIC = Bayesian information criterion. SSABIC = sample size adjusted BIC.

Fruit = risk of not meeting fruit intake guidelines. Vegetables = risk of not meeting vegetable intake guidelines. Television time = mean daily hours spent watching TV. Device time = mean daily hours spent on electronic devices.

Table 6. Model-based between-group difference effect estimates at each time point for each outcome

	Estimate (95% CI)			
Health4Life *v* control	**Baseline**	**Post**	**12 months**	**24 months**
Binge drinking*	0.55 (0.16, 1.85)	1.21 (0.75, 1.95)	1.44 (0.51, 4.08)	1.64 (0.34, 7.01)
Discretionary food risk*	0.93 (0.64, 1.33)	1.00 (0.85, 1.14)	1.00 (0.76, 1.30)	0.99 (0.71, 1.39)
Fruit*	0.69 (0.32, 1.50)	1.01 (0.96, 1.05)	1.04 (0.75, 1.43)	1.08 (0.57, 2.05)
Vegetables*	1.01 (0.46, 2.19)	1.00 (0.94, 1.05)	0.97 (0.64, 1.47)	0.94 (0.41, 2.15)
Sleep difficulty*	1.14 (0.79, 1.65)	0.80 (0.60, 1.08)	0.75 (0.55, 1.02)	0.72 (0.51, 1.01)
Light physical activity†	0.93 (0.78, 1.12)	1.00 (0.98, 1.02)	1.00 (0.85, 1.17)	1.00 (0.72, 1.38)
Tobacco frequency‡	-0.02 (-0.11, 0.07)	0.00 (-0.04, 0.04)	0.04 (-0.13, 0.20)	0.11 (-0.10, 0.32)
Alcohol frequency‡	0.03 (-0.03, 0.10)	-0.02 (-0.07, 0.03)	-0.08 (-0.29, 0.14)	0.03 (-0.22, 0.27)
Alcohol harms‡	0.48 (-0.31, 1.26)	--	-0.12 (-0.81, 0.57)	-0.24 (-1.62, 1.13)
Daytime sleepiness‡	-0.33 (-0.83, 0.17)	-0.05 (-0.14, 0.03)	-0.20 (-0.55, 0.15)	0.04 (-0.45, 0.52)
Television time‡	0.17 (-0.12, 0.47)	-0.01 (-0.02, 0.00)	-0.07 (-0.18, 0.03)	-0.14 (-0.35, 0.06)
Device time‡	0.19 (-0.17, 0.55)	0.01 (-0.01, 0.02)	-0.04 (-0.18, 0.10)	-0.07 (0.29, 0.16)

CI = confidence interval.

* Logistic regression models, estimates are the model-based estimated odds ratios.

† Variable has 4 levels and was treated as ordinal; estimates are model-based estimated odds ratios for being in a higher risk category.

‡ Continuous linear regression models, estimates are differences in the model-based estimated means.

All models were adjusted for sex at birth and school location.

Fruit = risk of not meeting fruit intake guidelines. Vegetables = risk of not meeting vegetable intake guidelines. Television time = mean daily hours spent watching TV. Device time = mean daily hours spent on electronic devices.

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