BMJ Open

Impact of gastrointestinal conditions, restrictive diets and mental health on health-related quality of life: cross-sectional population-based study in Australia

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To cite: Stocks NP, Gonzalez-Chica D, Hay P. Impact of gastrointestinal conditions, restrictive diets and mental health on health-related quality of life: cross-sectional population-based study in Australia. *BMJ Open* 2019;**9**:e026035. doi:10.1136/bmjopen-2018-026035

► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2018-026035).

Received 16 August 2018
Revised 4 June 2019
Accepted 6 June 2019

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ABSTRACT

Objectives To assess the relationship between gastrointestinal conditions, restrictive diets, mental health and health-related quality of life (HRQoL).

Design Cross-sectional population-based face-to-face survey.

Setting South Australia.

Participants A representative sample of 2912 consenting adults (48.9±18.1 years; 50.9% females) investigated in 2015.

Primary and secondary outcome measures Participants self-reported diagnosis of gastrointestinal conditions, mental health and current use of restrictive diets. The physical component score (PCS) and mental component score (MCS) of HRQoL were investigated (Study Short Form 12 V.1 questionnaire). Linear regression models were used to test the associations, adjusting for (1) sociodemographic variables, (2) mental health status and (3) lifestyle and body mass index.

Results The prevalence of restrictive diets (36.1%; 95% CI 33.9 to 38.3) was higher among those with any self-reported gastrointestinal condition (60.7% vs 31.3% for those without these conditions; p<0.001). PCS was lower among those with a gastrointestinal condition (mean difference=−3.4; 95% CI −4.5 to −2.4) or on a restrictive diet (mean difference=−1.9; 95% CI −2.7 to −1.1), with a similar pattern, but with a smaller effect, observed for MCS. Being on a restrictive diet did not modify the relationship between having a gastrointestinal condition and reduced HRQoL. However, having a gastrointestinal condition was associated with a 2.4 points lower PCS (95% CI −3.5 to −1.3) among those without a mental health problem, while for those affected by a mental health condition this reduction was greater (mean difference=−5.9; 95% CI −8.7 to −3.1). For MCS, there was no evidence of interaction between mental health and gastrointestinal conditions.

Conclusions One-third of Australian adults are restricting their diet, and this is associated with lower HRQoL. Being on a restrictive diet was not associated with a better HRQoL among individuals with a gastrointestinal condition. Mental health problems were associated with a stronger adverse relationship between gastrointestinal diseases and physical HRQoL. Health professionals should be alert to these associations when trying to improve health outcomes for patients.

Strengths and limitations of this study

- A representative sample of the South Australian population.
- Validated face-to-face interviews of participants with a high response rate to questions.
- An annual survey exploring since 1991 a broad range of health issues.
- Causal inferences are not possible due to the cross-sectional design of this study.
- Reliance on participants self-report of medical conditions.

BACKGROUND

Chronic gastrointestinal diseases have a substantial impact on healthcare costs and utilisation.[1] In 2016, they affected 3.7% of the population worldwide (a 23% increase compared with 1990), with a reported prevalence of 17% in older Australians.[2] These conditions also affect productivity, through lost working days and reduced health-related quality of life (HRQoL).[1 3–7] Some chronic gastrointestinal diseases, such as irritable bowel syndrome (IBS) and gastro-oesophageal reflux disease (GORD), are relatively common but do not necessarily require ongoing medical review. Others, such as Crohn's disease, ulcerative colitis or coeliac disease, are less prevalent, but due to their more serious physical and mental health consequences, usually need ongoing treatment and regular follow-up with a healthcare provider.[8–10] Dietary change is often recommended as part of appropriate management for these conditions. For instance, a gluten-free diet to treat coeliac disease, and more recently the 'Fermentable Oligo-, Di-, Monosaccharides And Polyols' (FODMAPs) diet has been found to be effective for some people with IBS.[10–15] Interestingly, perhaps

as a consequence of increased health knowledge in the community or presumed health benefits, many people without diagnosed chronic gastrointestinal conditions are restricting their dietary intake of gluten, milk products and/or foods containing FODMAPs.[14 16–18] According to two recent surveys, 21% of Australian adults avoid wheat and/or dairy products, but 25% of them have no clinical condition or symptom to justify that decision.[19 20] Little is known about the long-term consequences of these dietary choices among those without diagnosed gastrointestinal conditions.

Although much has been published about the impact of gastrointestinal conditions on HRQoL,[3–7 21] only some studies have examined the added effect of dietary restrictions on this outcome. A recent review of dietary adherence in coeliac disease concluded that diet could improve but did not normalise HRQoL.[12] While for IBS, very few studies have examined the impact of dietary changes on patients' HRQoL.[22 23] Similarly, very little is known about dietary restriction and changes in HRQoL for those with GORD, Crohn's disease or ulcerative colitis. Therefore, with the noted exceptions of restriction in the context of obesity[24] and/or eating disorders,[25] the impact of dietary restrictions on HRQoL has been little studied.

Additionally, psychiatric comorbidity among patients with gastrointestinal conditions, either IBS, GORD, inflammatory bowel disease or coeliac disease, has been found to be associated with increased symptomatology, worse prognosis and reduced HRQoL.[26–32] In fact, in recent years, there has been an emerging interest in understanding the role of the gut–brain axis, as the complex interaction between nutrition, chronic inflammation and neurotransmitter concentrations seem to affect psychological processes and patient-centred outcomes.[26 27 29 33 34]

Finally, to our knowledge, no one has investigated the role of restrictive diets on HRQoL among individuals with or without gastrointestinal conditions using a population-based sample, or whether having a mental health condition changes the association between gastrointestinal conditions and HRQoL. Such information could help us develop better policies about health and food education. Therefore, this study aimed to explore the complex relationship between self-reported gastrointestinal conditions, restrictive diets, mental health status and HRQoL in a representative sample of the South Australian population. Our hypotheses were (1) that people reporting having a restricted diet, with or without a gastrointestinal condition, would have better HRQoL than those who did not and (2) having a mental health condition moderates the relationship between a gastrointestinal condition and/or restrictive diet and HRQoL.

METHODS

This study used data from a cross-sectional, face-to-face survey (Health Omnibus Survey) including a representative sample of adults living in South Australia (SA). In 2015, a complex sampling process was used to select participants. Details of the methodology have been published elsewhere.[35] Briefly, participants aged 15+ years were randomly chosen from a selection of 10 residences in each of the 530/3939 level 1 statistical areas selected for this study.[36] Individuals terminally ill/mental incapacitated (n=104) or unable to speak English (n=87) were excluded. The final sample included 3005 individuals (71.1% of the 4226 eligible), but only 2912 individuals aged 20+ years were included in the analysis.

Outcome

HRQoL was investigated using the Medical Outcomes Study Short Form 12 (SF-12) questionnaire V.1. The 12 questions included in this instrument were combined to generate the physical component score (PCS) and mental component score (MCS) summary scores of HRQoL in the last 4 weeks, with a mean value of 50 and SD of 10 (higher values indicating a better HRQoL).[37 38] The SF-12 has shown good psychometric properties, including test–retest reliability coefficients of 0.9 for PCS and 0.8 for MCS, and appropriate construct validity (relative validity for the discrimination of patients who differ in physical and mental health according to proven clinical measures PCS=0.93 and MCS=1.1).[39]

Gastrointestinal conditions and restrictive diet

The medical diagnosis of gastrointestinal conditions was self-reported ('*have you ever been told by a doctor that you have…*') and included GORD, IBS, Crohn's disease, ulcerative colitis and coeliac disease.

The current use of some restrictive diet included avoidance of milk/dairy products ('*Do you restrict your consumption of milk or dairy (lactose) products*'), gluten ('*Do you avoid products containing gluten (wheat)*') and/or other foods causing pain, bloating and/or diarrhoea ('*Do you avoid certain foods because they cause pain, bloating or wind*').

Two binary (yes/no) variables were generated based on the previous information: (1) positive for any of the investigated gastrointestinal conditions and (2) current use of some restrictive diet.

Covariates

Sociodemographic, mental health status, lifestyle and body mass index (BMI) were included as covariates for adjustment.[40–42] The sociodemographic variables included gender (male or female), age (in years, including a quadratic term for nonlinear associations with HRQoL), marital status (married/living with a partner vs single, divorced or widowed—binary variable), residence area (urban or rural), attained educational level (bachelor or higher; certificate/diploma; trade qualification; secondary; less than secondary), working status (employed full-time; employed part-time; unemployed (including students and home duties); retired) and socioeconomic position. The last variable was assessed using the 2011 Australian Socio-Economic Indexes for Areas Index of Relative Socio-economic Advantage and

Disadvantage, with high scores indicating the respondent residing in a more advantaged area.[43]

Mental health status was also included as a covariate for adjustment as conditions such as depression and anxiety are closely related to gastrointestinal conditions[42 44 45] and HRQoL.[46 47] Individuals were considered positive for a mental health condition when they self-reported receiving treatment for anxiety, depression or any other mental health problem (*'Are you currently receiving treatment for anxiety, depression, or any other mental health problem'*).

Finally, although lifestyle and BMI are possible confounders of the investigated associations, they might be on the causal pathway between exposure and outcome (eg, people might adopt healthier habits as a result of a gastrointestinal condition). Therefore, they were considered as covariates in a separated analytical model. Lifestyle variables included daily fruit/vegetable consumption (0–2, 3–4 or 5+ portions/day), 30+ minutes of moderate/vigorous physical activity (0–1, 2–4 or 5+ days/week), alcohol consumption (0–2, 3–4 or 5+ standard drinks/day) and smoking status (never, former or current smoker). BMI was estimated based on self-reported weight and height and classified as underweight (<18.5 kg/m^2), normal range (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2) or obese (≥30 kg/m^2).[48]

Data analysis

Categorical variables were described as percentages (%), while mean and SD or median with IQR (p25–p75) were used for numerical variables, depending on their symmetry. χ^2 test with Rao-Scott correction was used to verify the bivariate association between the covariates and the diagnosis of gastrointestinal conditions. The same procedure was used to evaluate the prevalence of individuals on a restrictive diet according to the covariates, stratified by the presence or not of the investigated gastrointestinal conditions. Tests for heterogeneity or trend were used accordingly.

Crude and adjusted linear regression models were used to evaluate the association between gastrointestinal conditions or the use of restrictive diets with HRQoL. Three different models with a consecutive level of adjustment were considered for analysis: (1) adjustment for sociodemographic variables, (2) additional inclusion of mental health status and (3) further adjustment for lifestyle variables and BMI. These covariates were included in the respective models independent of their p-value in the association with the outcomes. Mean differences were reported as regression coefficients (β) with their respective 95% CI and p values. Determination coefficients (r^2) were used to evaluate the overall model fit, while the variance inflation factor (VIF) was investigated as an indicator of collinearity between the explanatory variables. To explore the role of restrictive diets on HRQoL among individuals with a gastrointestinal condition, a multiplicative interaction term between these explanatory variables (ie, gastrointestinal condition and restrictive diet) was included in the regression models. Mental health status was also tested as a possible moderator of the association between gastrointestinal conditions and HRQoL, considering the available evidence in the literature.[26–32] When the heterogeneity of the association was verified (p value for interaction <0.05), predicted adjusted means of HRQoL were estimated in each category of the explanatory variables and presented graphically, stratified by the correspondent effect modifier.[49 50]

STATA V.14.0 was used for analysis, considering sampling weights (inverse of the individual's probability of selection within the household and reweighted to the estimated resident population in SA in 2014) and sampling design (clusters of statistical areas) based methods previously described and using as a benchmark data from the closest Australian census.[35 36]

Patient and public involvement

Patients and the public were not directly involved in the design or implementation of the survey that has been undertaken every year since 1991 for government and non-government organisations responsible for delivering healthcare to the South Australian community. Participants, as part of the consent process, were fully informed about the time burden of participation and the nature of the questions. Participants answered the survey only after they provided their verbal consent to participate in the study. Verbal rather than written informed consent was obtained due to the practicalities of carrying out a large-scale survey and the low-risk nature of the survey content.

RESULTS

A total of 2912 individuals aged 20+ years were included (mean age 48.9±18.1 years; 50.9% females). The most common gastrointestinal conditions were GORD (8.4%) and IBS (7.9%), while ulcerative colitis (0.9%), Crohn's disease (0.8%) and coeliac disease (0.7%) were less frequent. Food avoidance because of pain, bloating or diarrhoea was reported by 23.3%, while 19.8% followed a lactose-restricted diet, and 9.2% avoided gluten products.

Table 1 shows the prevalence of gastrointestinal conditions (16.4%; 95% CI 14.6 to 18.3) was higher among females, individuals aged 50+ years, or retired people, but was not different according to marital status, residence area, educational level or socioeconomic position. The prevalence of individuals on any restrictive diet (36.1%; 95% CI 33.9 to 38.3) was higher among those with a gastrointestinal condition (60.7%) versus those without a gastrointestinal condition (31.3%). The difference was statistically significant (p<0.001). Females or those with a certificate/diploma or higher educational level were more likely to be on a restrictive diet, independent of whether they had or not a gastrointestinal condition.

The daily consumption of fruit/vegetables was not associated with having a gastrointestinal condition (table 2). However, gastrointestinal conditions were more frequent among those reporting physical activity 0–1 days/week, low alcohol consumption, ex-smokers, obesity or with a

Table 1 Prevalence of gastrointestinal conditions* and use of some restrictive diet† according to sociodemographic variables. Individuals ≥20 years, South Australia, 2015 (n=2912)

		With a GI condition (16.4%)			Without a GI condition (83.6%)		
	N	n	%‡	On a restrictive diet (60.7%)§	n	%	On a restrictive diet (31.3%)§
Gender			‡	P=*0.001*			P<*0.001*
Males	1430	176	**12.3**	*(49.7)*	1254	*87.7*	*(26.5)*
Female	1482	302	**20.4**	*(67.1)*	1180	*79.6*	*(36.3)*
Age group (years)			‡	P=*0.380*			P=*0.005*
20–34	789	72	**9.1**	*(61.7)*	717	*90.9*	*(26.9)*
35–49	719	92	**12.7**	*(70.2)*	627	*87.3*	*(34.6)*
50–64	757	158	**20.9**	*(58.5)*	599	*79.1*	*(34.1)*
65–79	495	115	**23.2**	*(58.2)*	380	*76.8*	*(32.7)*
≥80	152	41	**26.8**	*(53.7)*	111	*73.2*	*(20.5)*
Marital status				P=*0.204*			P=*0.220*
Single, divorced or widowed	970	161	16.6	*(56.6)*	809	*83.4*	*(29.3)*
Married or living with partner	1942	317	16.3	*(62.8)*	1625	*83.7*	*(32.2)*
Area of residence				P=*0.174*			P=*0.201*
Urban	2172	380	17.5	*(62.3)*	1792	*82.5*	*(32.2)*
Rural	740	98	13.3	*(54.5)*	642	*86.7*	*(28.8)*
Attained educational level				P=*0.045*			P=*0.019*
Bachelor or higher	743	117	15.7	*(63.9)*	626	*84.3*	*(32.5)*
Certificate/diploma	821	146	17.8	*(68.5)*	675	*82.2*	*(34.8)*
Trade qualification	384	50	13.1	*(60.7)*	334	*86.9*	*(28.3)*
Secondary	705	117	16.6	*(53.8)*	588	*83.4*	*(25.7)*
Less than secondary	259	48	18.4	*(45.8)*	211	*81.6*	*(32.5)*
Working status			‡	P=*0.606*			P=*0.091*
Employed full time	1083	128	**11.8**	*(60.5)*	955	*88.2*	*(29.8)*
Employed part time	594	95	**16.0**	*(67.3)*	499	*84.0*	*(36.6)*
Not working	577	96	**16.7**	*(57.6)*	481	*83.3*	*(30.6)*
Retired	658	159	**24.1**	*(58.9*	499	*75.9*	*(29.4)*
Socioeconomic position (quartiles)¶				P=*0.788*			P=*0.030*
High	722	108	15.0	*(57.6)*	614	*85.0*	*(33.8)*
Middle-high	725	121	16.7	*(62.0)*	604	*83.3*	*(34.1)*
Middle-low	647	114	17.6	*(64.3)*	533	*82.4*	*(29.5)*
Low	818	135	16.5	*(59.3)*	683	*83.5*	*(28.0)*

*Including irritable bowel syndrome, celiac disease, Crohn's disease, ulcerative colitis and/or gastrointestinal reflux.
†Including the restriction of milk/dairy products, gluten and/or if they avoid other foods causing pain, bloating and/or diarrhoea.
‡Values in bold represent those cases where the prevalence of gastrointestinal conditions was different at a p<0.05.
§Values in parenthesis represent the percentage of individuals on a restrictive diet in the corresponding strata (with or without a gastrointestinal condition).
¶Based on the Socio-Economic Indexes for Areas Index of Relative Socio-economic Advantage and Disadvantaged.
Italicised values have been provided for each sociodemographic variable- gender, age group, marital status, area of residence, attained educational level, working status and socioeconomic postion. The P value reported relates to differences between the proportions reporting the levels of each variable eg, male vs female or differences between age groups.
GI, gastrointestinal condition.

Table 2 Prevalence of gastrointestinal conditions* and use of some restrictive diet† according to lifestyle variables, BMI and mental health status. Individuals ≥20 years, South Australia, 2015 (n=2912)

		With a GI condition (16.4%)			Without a GI condition (83.6%)		
	N	n	%‡	On a restrictive diet (60.7%)§	n	%‡	On a restrictive diet (31.3%)§
Fruit/vegetable consumption				P=*0.015*			P=*0.003*
0–2 portions/day	840	134	16.0	*(53.9)*	706	84.0	*(25.2)*
3–4 portions/day	1140	193	16.9	*(59.1)*	947	83.1	*(33.6)*
5+ portions/day	928	150	16.2	*(68.9)*	778	83.8	*(34.0)*
Physical activity			‡	P=*0.954*			P=*0.469*
0–1 days/week	862	177	**20.6**	*(60.2)*	685	79.4	*(31.0)*
2–4 days/week	1051	141	**13.4**	*(61.9)*	910	86.6	*(33.0)*
5–7 days/week	998	159	**15.9**	*(60.3)*	839	84.1	*(29.7)*
Alcohol intake			‡	*0.091*			P=*0.044*
0–2 doses/day	1902	335	**17.6**	*(59.3)*	1567	82.4	*(33.4)*
3–4 doses/day	597	98	**16.4**	*(70.3)*	499	83.6	*(27.0)*
5+ doses/day	413	44	**10.7**	*(50.5)*	369	89.3	*(28.0)*
Smoking status			‡	P=*0.053*			P=*0.839*
Never smoker	1224	169	**13.8**	*(64.5)*	1055	86.2	*(32.0)*
Ex-smoker	1227	250	**20.4**	*(55.6)*	977	79.6	*(30.7)*
Current smoker	456	58	**12.8**	*(72.2)*	398	87.2	*(30.6)*
BMI categories (kg/m^2)			‡	P=*0.205*			P=*0.245*
Underweight (<18.5)	58	5	**8.1**	*(83.9)*	53	91.9	*(28.3)*
Normal (18.5–24.9)	1069	172	**16.1**	*(65.4)*	897	83.9	*(34.3)*
Overweight (25.0–29.9)	1048	145	**13.8**	*(55.8)*	903	86.2	*(29.3)*
Obesity (≥30.0)	737	156	**21.2**	*(59.5)*	581	78.8	*(30.0)*
Mental health problem			‡	P=*0.112*			P=*0.195*
No	2532	370	**14.6**	*(61.1)*	2162	85.4	*(30.8)*
Yes	372	107	**28.8**	*(59.4)*	265	71.2	*(35.2)*

*Including irritable bowel syndrome, celiac disease, Crohn's disease, ulcerative colitis and/or gastrointestinal reflux.
†Including the restriction of milk/dairy products, gluten and/or if they avoid other foods causing pain, bloating and/or diarrhoea.
‡Values in bold represent those cases where the prevalence of gastrointestinal conditions was different at a p<0.05.
§Values in parenthesis represent the percentage of individuals on a restrictive diet in the corresponding strata (with or without a gastrointestinal condition).
Italicised values have been provided for each variable- fruit and vey consumption, physical activity, alcohol intake, smoking status, BMI categories, Mental heath problem. The P value reported relates to differences between the proportions reporting the levels of each variable eg, smoking status - never vs ex vs current.
BMI, body mass index; GI, gastrointestinal condition.

mental health problem. Table 2 also shows that individuals with higher fruit/vegetable consumption were also more likely to be on a restrictive diet, independent of their gastrointestinal status. None of the other lifestyle variables, BMI or mental health status was associated with the prevalence of restrictive diets in either group.

Table 3 summarises the association between gastrointestinal conditions and restrictive diets with HRQoL. Except for the relationship between gastrointestinal conditions and PCS, results adjusted for sociodemographic variables showed small differences compared with crude results. All gastrointestinal conditions and restrictive diets showed negative β coefficients (ie, negative values for the mean differences, indicating a lower HRQoL). However, for PCS, only the associations with GORD, IBS, restriction of food related to pain, bloating, or diarrhoea, and lactose-restricted diets were statistically significant. For MCS, the significant associations were observed with GORD, IBS, ulcerative colitis and restriction of food related to pain, bloating or diarrhoea. Consequently,

Table 3 Prevalence of gastrointestinal conditions and use of restrictive diets and their association with health-related quality of life (physical component score and mental component score) among individuals ≥20 years in South Australia in 2015 (n=2912)

			Physical component score		Mental component score	
	Yes		Crude	Adjusted*	Crude	Adjusted*
	n	%	β (95% CI)†	β (95% CI)†	β (95% CI)†	β (95% CI)†
Gastrointestinal condition						
Gastro-oesophageal reflux	245	8.4	**−6.1 (−7.9 to −4.4)**	**−3.7 (−5.2 to −2.2)**	**−2.3 (−3.9 to −0.6)**	**−2.4 (−3.8 to −0.9)**
Irritable bowel syndrome	230	7.9	**−4.7 (−6.5 to −3.0)**	**−3.3 (−4.9 to −1.8)**	**−3.3 (−4.7 to −2.0)**	**−2.9 (−4.2 to −1.6)**
Ulcerative colitis	26	0.9	−5.0 (−10.1 to 0.2)	−2.7 (−7.1 to 1.7)	**−6.0 (−9.5 to −2.6)**	**−5.7 (−9.0 to −2.3)**
Crohn's disease	23	0.8	−4.7 (−10.8 to 1.3)	−4.4 (−9.4 to 0.6)	−2.4 (−7.1 to 2.3)	−2.5 (−6.7 to 1.7)
Coeliac disease	20	0.7	−1.7 (−5.8 to 2.5)	−1.7 (−5.2 to 1.9)	−0.6 (−3.8 to 2.6)	−0.5 (−3.4 to 2.5)
Any‡	478	16.4	**−5.2 (−6.4 to −4.0)**	**−3.4 (−4.5 to −2.4)**	**−2.6 (−3.6 to −1.5)**	**−2.5 (−3.5 to −1.5)**
Restrictive diet						
Avoid foods for pain, bloating or diarrhoea	678	23.3	**−2.3 (−3.4 to −1.3)**	**−2.1 (−3.0 to −1.1)**	**−1.6 (−2.6 to −0.7)**	**−1.4 (−2.3 to −0.5)**
Lactose restricted	577	19.8	**−1.3 (−2.3 to −0.3)**	**−1.4 (−2.3 to −0.5)**	**−1.1 (−1.9 to −0.2)**	**−1.0 (−1.8 to −0.1)**
Gluten restricted	268	9.2	−0.7 (−2.0 to 0.7)	−1.0 (−2.2 to 0.2)	**−1.7 (−3.0 to −0.3)**	−1.3 (−2.6 to 0.1)
Any§	1051	36.1	**−2.1 (−3.0 to −1.2)**	**−1.9 (−2.7 to −1.1)**	**−1.5 (−2.2 to −0.7)**	**−1.3 (−2.0 to −0.5)**

*Results are adjusted for sex, age, marital status, area of residence, educational level, working status and socioeconomic position.
†The β coefficients represent the mean difference in health-related quality of life between those positive for that condition and the negative ones. Numbers in bold represent the associations with statistical difference between the groups (p<0.05).
‡Either with irritable bowel syndrome, coeliac disease, Crohn's disease, ulcerative colitis and/or gastrointestinal reflux.
§Either those restricting milk/dairy products, gluten and/or if they avoid other foods causing pain, bloating and/or diarrhoea.

having any gastrointestinal condition, or being on any restrictive diet, were both associated with lower HRQoL, especially with PCS. The adjusted r^2 for PCS increased from 21.0% (including all sociodemographic variables) to 22.4% and 21.7% when the combined gastrointestinal or restrictive diet variables were included in the model, respectively. For MCS, the adjusted r^2 remained steady at 10.0% even after any of the variables were included in the regression models. No evidence of multicollinearity between the independent variables was identified (mean VIF=1.9 for both outcomes). Further adjustment for mental health status (model 2) or lifestyle variables and BMI (model 3) had no substantial effect on the observed associations (online supplementary table S1) .

Being on a restrictive diet was not an effect modifier of the association between having a gastrointestinal condition and HRQOL (p value for interaction >0.4 for PCS or MCS). Nonetheless, mental health problems were not only twice as frequent among those with a gastrointestinal condition (22.5% vs 10.9% for those without these diseases), but having a mental health problem was also identified as a moderator of the association between gastrointestinal conditions and PCS (p value for interaction 0.02; figure 1). Among those without a mental health problem, having a gastrointestinal conditions was associated with a 2.4 points lower PCS (95% CI −3.5 to −1.3), while for those with a mental health problem this reduction was greater (−5.9 points; 95% CI −8.7 to −3.1). For MCS, having a mental health problem was associated with a lower HRQoL score (−9.5 points; 95% CI −10.9 to −8.1), but there was little evidence of interaction with the

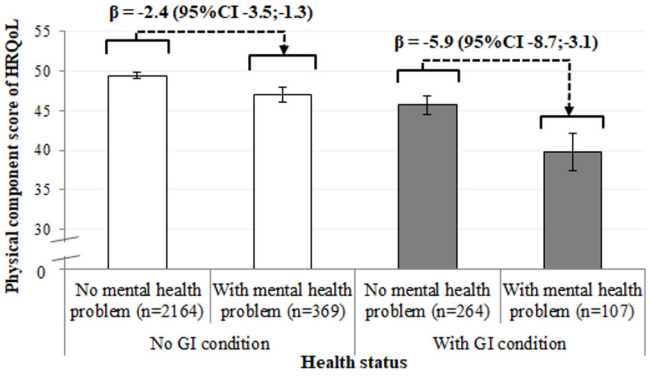

Figure 1 Association between the presence of gastrointestinal conditions and the physical component of health-related quality of life among individuals ≥20 years in South Australia in 2015 (n=2912), stratified by the presence of mental health problems. Gastrointestinal (GI) conditions include those who had irritable bowel syndrome, celiac disease, Crohn's disease, ulcerative colitis and/or gastrointestinal reflux. Mental health problems include those on medication for depression, anxiety or other mental condition. Results are adjusted for sex, age, marital status, area of residence, educational level, working status and socioeconomic position. Vertical lines represent the 95% CI in each category.

presence of gastrointestinal conditions (p value for interaction 0.09). A summary of the study findings can be found in online supplementary figure 1.

DISCUSSION

In this population-based cross-sectional study, almost a third of the sample was on some form of restricted diet. Those with a gastrointestinal condition were twice as likely as those without a gastrointestinal condition to be restricting their diet. Women, those with a higher education level, and people in higher socioeconomic groups were also more likely than others to restrict their diet. Having any gastrointestinal condition or being on a restricted diet were both associated with lower HRQoL, but the relationship was stronger with PCS. Moreover, being on a restrictive diet was not associated with a better HRQoL among individuals with a gastrointestinal condition. Having a mental problem was associated with a stronger adverse relationship between gastrointestinal conditions and PCS.

Estimates of the community prevalence of gastrointestinal conditions vary considerably.[2] Our figure for IBS (7.9%) is at the lower end of the prevalence identified in other studies, with published pooled prevalence of 11.2% (95% CI 9.8% to 12.8%). Prevalence estimates varied according to country (from 1.1% to 45.0%) and criteria used to define IBS.[8] For GORD, the frequency we identified in SA (8.4%) was also lower than the Australian estimate of 11.6%.[9] However, for coeliac disease, our results (0.7%) are comparable with the estimated prevalence among Australian adults (0.56%–0.96%).[51] There do not appear to be any recent estimates for the prevalence of Crohn's disease and ulcerative colitis in Australia, although the incidence is apparently increasing.[52] Self-report of the investigated conditions may account for these discrepancies, considering the intermediate levels of sensitivity for such kind of information (ranging from 33% to 85%), even though reliability and specificity are considered satisfactory.[53 54] Overall, our data are consistent with previous estimates for conditions that require ongoing medical follow-up and less for those that do not, such as IBS or GORD.[8 9]

By comparison few population estimates exist for dietary restriction (or food avoidance/intolerance) in Australia. The Commonwealth Scientific and Industrial Research Organisation undertook a national survey in 2013 that found 7.3% of their sample reported physiological effects, mainly gastrointestinal, that the individual believed was due to wheat.[19] In the same survey, 11.8% of the sample reported avoiding dairy products because of adverse physiological effects.[20] However, the National Health and Nutrition Survey 2011–2012 identified that 17% of Australians reported food avoidance due to allergy or intolerance with their estimates for cow's milk/dairy (4.5%) and gluten (2.5%) avoidance being much lower than ours (19.8% and 9.2%, respectively).[55] These differences may reflect an increase in the availability and accessibility to gluten-free and lactose-free products in recent years. This would make it easier to follow restrictive diets, not only for people with an established clinical diagnosis but also for those affected by some form of sensitivity, intolerance and/or allergic reaction to these diet components.[14 17 18] Another explanation for the higher prevalence of restrictive diets in our study are changes in knowledge or beliefs about foods or terminology used, with people defining their behaviours as a restriction, avoidance, intolerance or elimination, which therefore results in different estimates of their frequency.[18]

While there are many cultural, religious, ethical or economic reasons for eating, or not eating, particular foods,[56] there are potential health implications for dietary restriction (especially gluten-free diets), when not medically indicated or appropriately supervised.[13 15 18] Furthermore, dietary restriction may be taken to extreme, as in the orthorexia nervosa syndrome,[57] with subsequent adverse effects on health status and HRQoL.

Some studies have reported impaired HRQoL in those with chronic gastrointestinal conditions, including IBS, GORD, coeliac disease and inflammatory bowel disease.[3–7 29] However, results regarding the benefits of following a restrictive diet on HRQoL are controversial, as some studies identified no associations with this outcome,[42] while others report that individuals with a gastrointestinal condition that received support to modify their diet show improvements in their HRQoL.[12 22 23 42] Contrary to our original hypothesis, individuals following a restrictive diet had a lower HRQoL (PCS and MCS), even among those without a history of gastrointestinal problems. Reverse causality could explain these results: individuals with a more severe condition and reduced HRQoL following a restrictive diet to ameliorate their symptoms. The same explanation is also plausible for the results identified among those without any of the investigated gastrointestinal diseases. This group could include a number of undiagnosed cases, individuals with other gastrointestinal conditions, or even those affected by a wider spectrum of sensitivity/allergy to different diet components.[14 18] It is also possible that these individuals have other undiagnosed mental health or physical conditions affecting their HRQoL which we have not adjusted for (residual confounding). Therefore, a history of dietary restriction, or for that matter low quality of life in a person who is seemingly otherwise healthy, should alert health professionals for the need to search for underlying health problems. In any case, further studies in this field are necessary to elucidate the influence of other possible determinants of HRQoL, because after accounting for the variables under investigation, there is still a lot of unexplained variance in the outcomes.

Mental health status also seems to have a central role in the association between gastrointestinal diseases and HRQoL.[42 44 45] The lower HRQoL score among those affected by a mental health problem may be a consequence of the 'affective fallacy bias'. Individuals with mental health problems tend to report lower well-being

and/or satisfaction with their life when compared with the assessment by an independent observer.[46 47] However, this information bias does not explain the substantially lower PCS among those affected by a gastrointestinal condition in our study. There is evidence that the same immunological disturbances, oxidative stress, autonomous nervous system dysfunction and gut–brain axis interactions that play a role in the pathophysiology of gastrointestinal conditions, also increase the susceptibility for mental health problems, such as depression and anxiety.[26 27 29 33 34 42 44 45] At the same time, the coexistence of psychiatric problems seem to alter the course of gastrointestinal disease, as they increase recurrence, the severity of symptoms, and interfere with the treatment of these conditions, thus leading to a reduction in HRQoL.[21 44 45]

Strengths and limitations

The strength of this study is the survey methodology that is based on a probability sample of the South Australian population which has good representativeness and response rates obtained over many years.[35] Furthermore, the survey was anonymous, conducted face-to-face with trained interviewers, and with a high response rate to all questions. However, some limitations should be recognised. First, causal inferences are not possible due to the cross-sectional design of this study. Another limitation of the study is reliance on self-report, which can affect the validity of information regarding the diagnosis of chronic health conditions and lifestyle variables.[53] Correlated misclassification and residual confounding for mental health problems cannot also be excluded as the diagnosis was only based on the reporting of medication use. Nonetheless, estimates for most medical conditions derived from this survey reflect previous figures in other Australian and international studies. Moreover, this information bias is less likely to explain our results of a lower HRQoL among those affected by a gastrointestinal condition or following a restrictive diet, as it would have reduced the effect magnitude of the associations.

CONCLUSIONS

In a large population-based survey, South Australians self-report frequencies of gastrointestinal conditions that are similar to previous estimates. One-third of Australians are restricting their diet, and this is associated with lower HRQoL, especially the physical domain. Women, those from higher socioeconomic groups and middle-aged people are more likely to restrict their diet. Being on a restrictive diet was not associated with a better HRQoL among individuals with a gastrointestinal condition, but having a mental health problem was associated with a stronger adverse relationship between gastrointestinal diseases and the physical HRQoL. Health professionals should be alert to these associations and interactions when trying to improve health outcomes for their patients.

Acknowledgements The author acknowledges the participants of the 2015 Spring Health Omnibus Survey for their participation in this study.

Contributors NS and DG-C conceived the study, analysed, interpreted the data and wrote the manuscript. PH contributed with additional data necessary to complete the analysis and in writing the manuscript. All authors read and approved the final manuscript.

Funding DG-C received a part-fellowship from the NHMRC Centre of Research Excellence to Reduce Inequality in Heart Disease to conduct this study.

Competing interests None declared.

Patient consent for publication Obtained.

Ethics approval The protocol of this study and the data collection process were approved by the University of Adelaide Human Research Ethics Committee (project H-097-2010).

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement The datasets used and/or analysed for this study are available from the corresponding author on reasonable request.

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