



## Original Article

# Health-seeking behaviour, views and preferences of adults with suspected increased intestinal permeability: A cross-sectional survey of Australian adults



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## ABSTRACT

**Background:** The public health consequence of increased intestinal permeability (IP) is currently limited by the lack of patient-centred research. This study aims to describe the health-seeking behaviour of Australian adults with suspected IP.

**Methods:** A cross-sectional survey of 589 Australian adults who have been diagnosed with IP or have suspected (undiagnosed) IP.

**Results:** The majority (56.2%) of participants with suspected IP reported self-diagnosing their condition, with the majority (56.7%) of these participants preferring to be assessed using an accurate method by a general practitioner or naturopath. On average, Australian adults with suspected IP spent 11.1 (95% CI: 9.5, 12.8) years between first suspecting IP and receiving a formal diagnosis. Over the previous 12 months, participants spent an average of \$699 on consultation fees, \$2176 on dietary supplements for the treatment of IP, and an average of \$287 on the assessment of IP. Furthermore, participants who find it difficult to live on their available household income spent significantly more (mean=\$2963) on dietary supplements compared to participants who find it easy to live on their available household income (\$1918) ( $p=0.015$ ).

**Conclusion:** The investigation of Australian adults with suspected IP found the majority of participants experienced a considerable length of time between first suspecting IP and receiving a diagnosis of IP. The out-of-pocket expenditure associated with the management of IP suggests a financial burden for people with suspected IP. The results of this study provide novel patient-centred considerations that can be used to inform a clinical practice guideline for the management of IP.

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## 1. Introduction

The single layer of epithelial cells that separate the internal and external environment of the small intestine is renewed every four to five days, playing an essential role in maintaining intestinal homeostasis.<sup>1</sup> Increased intestinal permeability (IP) involves the disassembling of tight junction proteins between the cells of the small intestine, resulting in a loss of intestinal barrier integrity.<sup>2</sup> With an estimated prevalence of 10–87% in health conditions with a known association,<sup>3</sup> altered IP has been suggested to play an

important role in health and disease in both public and private healthcare.<sup>4</sup>

The clinical relevance and consequence of altered IP remain a controversial topic within conventional medicine.<sup>5</sup> Yet, published literature continues to identify IP as a target for disease prevention and therapeutic intervention.<sup>4</sup> IP has been suggested to precede the onset of a number of chronic health conditions such as Crohn's disease,<sup>6</sup> liver disease,<sup>7</sup> type 1 diabetes,<sup>8–11</sup> coeliac disease,<sup>9</sup> rheumatoid arthritis,<sup>12</sup> gestational diabetes,<sup>13</sup> and diarrhoea-predominant irritable bowel syndrome.<sup>14,15</sup> Altered IP is also associated with autoimmune conditions, metabolic conditions, liver diseases, and gastrointestinal conditions.<sup>3,16</sup> Although IP is a reaction within the small intestine, many of the measurable and clinically relevant risk factors are systemic, suggesting that IP is more than a digestive health issue and a possible feature of disease.<sup>16</sup>

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Previous research has investigated the assessment and management of IP from the practitioner standpoint, where practitioners acknowledge the involvement of IP in many health conditions found in clinical practice.<sup>17,18</sup> Within clinical practice, the pathology tests available are invasive, require patients to pay out-of-pocket, and involve a substantial amount of time to perform.<sup>18</sup> Practitioners that frequently treat IP in clinical practice are reported to avoid using validated pathology tests due to the financial cost to the patient and prioritise case history to diagnose IP.<sup>18</sup> While the frequency of methods used by patients, including the accuracy of self-diagnosis remains unknown, the self-diagnosis of other chronic illnesses such as diabetes is considered to be somewhat accurate.<sup>19</sup> Furthermore, no research to date has considered patients views and preferences towards the assessment and management of IP, resulting in knowledge gaps for evidence-based practice. Incorporating patients views and preferences in the decision-making process is often overlooked however, a positive impact on the outcome of healthcare is observed when patients views and preferences are considered.<sup>20</sup> As such, this study aims to describe the health-seeking behaviour of Australian adults with suspected IP while also exploring the views and preferences surrounding the assessment and management of IP.

## 2. Methods

### 2.1. Study design and setting

A cross-sectional study design using an online self-reported survey was utilised with approval from the Human Research Ethics Committees (HREC) of the University of Technology Sydney (#ETH19-4012).

### 2.2. Participants and recruitment

Participants were recruited via social media platforms and a purpose-built webpage, with snowball sampling methods also used. The survey was open for two months between September 2019 and November 2019. Eligibility to participate in this study required participants to either suspect or know they have altered IP, be aged 18 years or more, living in Australia and have internet access. Survey responders with incomplete demographic characteristics, accounting for <5% of total data were excluded from analysis. This study was designed to capture people that may have suspected IP or confirmed IP, to best reflect the type of patients that present to clinical practice for the treatment of IP.<sup>18</sup>

### 2.3. Survey instrument

The developed online survey utilised the questionnaire items which were obtained from published literature and modified to suit Australians with suspected IP.<sup>17,18</sup> To improve the survey's reliability, standardised five-point Likert scales were used for scaling questions. The survey included three main domains: demographic characteristics, diagnosis of IP, and the financial expenditure related to IP. The questionnaire was first pilot tested using lay people to assess the time required to complete the survey and language clarity, with corrections made accordingly.

#### 2.3.1. Demographic characteristics

The participants were asked about their gender, age, height, and weight. Body mass index (BMI) was calculated from height and weight measurements. BMI was then categorised to underweight, healthy weight, overweight, and obese.<sup>21</sup> The participants were also asked their country of birth, the state or territory where they live, and whether they live in an urban, rural or remote location.

#### 2.3.2. Diagnosis of increased intestinal permeability

Participants were asked a number of questions in relation to the assessment of IP including: the year they believed their IP started, the year their IP was diagnosed, the method used to confirm their IP, at what point their IP was assessed, the number of times their IP was assessed, and the qualifications of the practitioner involved in the assessment of their IP. In addition, participants preference for IP testing method characteristics, the preferred method and time point for IP assessment, and the qualifications of their preferred practitioner were all asked. To gauge the preference and importance towards being assessed for IP and the likelihood of treatment adherence if results returned a positive test of altered IP, five-point Likert scales were used. The term 'assessed' and 'assessment' are used throughout this article to describe the action participants used for measuring, evaluating or identifying IP.

#### 2.3.3. Financial expenditure

A number of items participants were asked to report: the out-of-pocket expenditure of treating IP, practitioner consultation fees, and cost of measuring IP. Participant's income manageability was determined by how well they manage their household income, categorised as 'difficult all the time', 'difficult some of the time', 'not too bad', or 'easy'. The amounts are reported in Australian dollars (AUD).

### 2.4. Data collection

The survey was administered through the online platform *SurveyGizmo*. After data collection, data was exported to a statistical software program STATA® 16 for data checking and statistical analyses.

### 2.5. Statistical analyses

Responses to questionnaire items were reported as means, standard deviations, 95% confidence intervals (CIs) or frequencies and percentages. Chi-square analysis was used for tests of association between categorical variables and Student's t-tests were used for continuous variables across a binary variable. Ordinal variables such as those on Likert scales were assessed with non-parametric tests, including Mann-Whitney U test and the Wilcoxon signed ranks test, where appropriate. Analysis of variance (ANOVA) was used to measure the difference between a continuous variable across a categorical variable.

## 3. Results

### 3.1. Demographic characteristics

A total of 982 people responded to the survey, of which 393 responses did not meet the eligibility criteria or were classified as having too much incomplete data, leaving a total of 589 participants. Most participants were female (n=548, 93%), living within an urban area (n=416, 70.6%) in either New South Wales (n=175, 29.7%) or Queensland (n=161, 27.3%) (Table 1). The mean age of the participants was 45.0 (SD=12.1) with a mean BMI of 27.0 (SD=6.9). The income manageability of participants was described most commonly as 'easy or not too bad' (n=209, 46.5%) and 'difficult some of the time' (n=145, 32.3%). Half the surveyed population reported altered IP as their primary health concern (n=300, 50.9%) with a range of other autoimmune, inflammatory gastrointestinal, and metabolic conditions reported for the other half (Table 1).

### 3.2. Diagnosis of increased intestinal permeability

The most frequently used methods to diagnose IP were self-diagnoses (n=330, 56.2%) and case history, according to a health-

**Table 1**  
Demographic characteristics of study participants (n=589)

Demographics	Distribution of responses	
	n	%
<b>Gender</b>		
Female	548	93.0
Male	41	7.0
<b>BMI classification</b>		
Underweight	19	3.3
Healthy weight	268	46.1
Overweight	138	23.8
Obese	156	26.9
<b>Country of birth</b>		
Australia	476	81.0
Other	112	19.0
<b>State or territory</b>		
New South Wales	175	29.7
Queensland	161	27.3
Victoria	103	17.5
Western Australia	63	10.7
South Australia	36	6.1
Australian Capital Territory	23	3.9
Tasmania	18	3.1
Northern Territory	10	1.7
<b>Area of residence</b>		
Urban	416	70.6
Rural	161	27.3
Remote	12	2.0
<b>Income manageability</b>		
Easy or not too bad	209	46.5
Difficult some of the time	145	32.3
Difficult all the time	95	21.2
<b>Primary health concern</b>		
Increased intestinal permeability	300	50.9
Other autoimmune diseases	40	6.8
Hashimoto's thyroiditis	28	4.8
Gastrointestinal issues	24	4.1
Chronic fatigue syndrome	21	3.6
Rheumatoid arthritis	18	3.1
Obesity	15	2.6
Mental health	13	2.2
Hormonal issues	10	1.7
Fibromyalgia	9	1.5
Gastrointestinal <i>Candida albicans</i>	8	1.4
Psoriatic arthritis	7	1.2
Mould exposure	7	1.2
Irritable bowel syndrome	6	1.0
Ankylosing spondylitis	6	1.0
Asthma	6	1.0
Food intolerances	6	1.0
Cardiovascular disease	6	1.0
Mast cell activation syndrome	6	1.0
Other health conditions	53	9.0
	<b>Mean</b>	<b>SD (range)</b>
Age in years	45.0	12.1 (18-82)
Body Mass Index (BMI)	27.0	6.9 (15.4-64.5)

care practitioner (n=130, 22.2%) (Table 2). From the participants that were assessed for IP, 17.3% (n=102) were assessed before receiving treatment, 4.1% (n=24) during the treatment phase, and only 1.4% (n=8) after treatment was completed. Of the participants who were diagnosed with IP, 59.1% (n=140) reported being diagnosed within the last three years. However, on average, participants with suspected IP spent 11.1 (95% CI: 9.5, 12.8) years between first suspecting IP and receiving a diagnosis. No statistically significant difference was found between the length of time between when participants first suspected IP to the year they were diagnosed and whether they were diagnosed by a medical practitioner or another healthcare practitioner (p=0.120). The vast ma-

**Table 2**  
Health seeking behaviour for the assessment and management of increased intestinal permeability by Australian adults (n=589)

Health Seeking Behaviour	Distribution of Response	
	n	%
<b>Method of assessment (n=587)</b>		
Self-diagnosed	330	56.2
Case history according to a practitioner	130	22.2
IgG food sensitivity test	29	4.9
Hemaview - live blood analysis	23	3.9
Stool zonulin	22	3.8
Lactulose/mannitol urine test	17	2.9
I don't know	16	2.7
Iridology	12	2.0
Serum zonulin	4	0.7
Kinesiology	4	0.7
<b>Stage that IP was measured (n=134)</b>		
Before treatment	102	17.3
During the treatment phase	24	4.1
After treatment was completed	8	1.4
<b>Number of times measured for IP (n=589)</b>		
0	459	77.9
1	104	17.7
2 +	26	4.4
<b>Time between initial and second assessment (n=26)</b>		
Between 1 and 6 months	2	7.7
Between 6 and 12 months	11	42.3
Between 12 and 24 months	6	23.1
Over 2 years	7	26.9
<b>Year IP was diagnosed (n=237)</b>		
< 3 years	140	59.1
4-6 years	46	19.4
7-9 years	22	9.3
> 10 years	29	12.2
<b>Year participant believe IP started (n=498)</b>		
< 3 years	84	16.9
4-6 years	82	16.5
7-9 years	77	15.5
> 10 years	255	51.2

IP: increased intestinal permeability

jority of participants were not assessed for IP (n=459, 77.9%) with only 17.7% (n=104) assessed once, and 4.4% (n=26) assessed more than twice. For the participants that were assessed two or more times, the second assessment of IP typically took place between 6 and 12 months (n=11, 42.3%). A significant association between the number of times IP was assessed and the person (practitioner or self) who diagnosed IP was found (p<0.001). Specifically, health-care practitioners and medical practitioners more frequently assessed IP (n=74, 33.9%; n=39, 33.6%, respectively) compared to those who self-diagnosed (n=4, 1.9%).

### 3.3. Practitioners involved in the diagnosis of increased intestinal permeability

Most participants (n=374, 67.4%) first suspected they had IP, whereas 32.6% (n=181) had a practitioner first suggest IP as a possible diagnosis. Participants were most frequently diagnosed with IP by self-diagnosing (n=274, 47.9%), followed by a naturopath (n=207, 36.2%), integrative medicine practitioner (n=82, 14.3%), nutritionist (n=53, 9.3%), and general practitioner (n=50, 8.7%) (Table 3). Most participants preferred their IP to be assessed by a naturopath (n=363, 63.5%), followed by a general practitioner (n=310, 54.2%), integrative medicine practitioner (n=259, 45.3%), nutritionist (n=225, 39.3%), gastroenterologist (n=221, 38.6%) or a dietitian (n=162, 28.3%). From the participants that self-diagnosed,

**Table 3**  
Practitioners involved in the diagnosis of increased intestinal permeability (n=572)

Who diagnosed increased intestinal permeability	Diagnosis of increased intestinal permeability					
	Initial diagnosis		Total preferred practitioner		Preferred practitioner for self-diagnosed	
	n	%	n	%	n	%
Naturopath	207	36.2	363	63.5	118	56.7
Integrative medicine practitioner	82	14.3	259	45.3	75	36.1
Nutritionist	53	9.3	225	39.3	69	33.2
General practitioner	50	8.7	310	54.2	118	56.7
Herbalist	19	3.3	101	17.7	31	14.9
Kinesiologist	19	3.3	86	15.0	22	10.6
Dietitian	17	3.0	162	28.3	60	28.9
Chinese medicine practitioner	15	2.6	110	19.2	35	16.8
Homeopath	13	2.3	77	13.5	24	11.5
Acupuncturist	11	1.9	78	13.6	26	12.5
Chiropractor	11	1.9	58	10.1	18	8.7
Gastroenterologist	10	1.8	221	38.6	90	43.3
Ayurvedic practitioner	6	1.1	73	12.8	25	12.0
Osteopath	4	0.7	40	7.0	13	6.3
Nurse	3	0.5	53	9.3	19	9.1
Nurse practitioner	3	0.5	52	9.1	18	8.7
Pharmacist	1	0.2	54	9.4	14	6.7
Self-diagnosed	274	47.9	-	-	-	-

their preferred practitioner for the assessment of IP was a general practitioner (n=118, 56.7%) or a naturopath (n=118, 56.7%).

### 3.4. Expenditures related to the assessment and management of intestinal permeability

On average, participants reported spending \$698.78 on consultation fees and \$2175.96 on dietary supplements over the previous 12 months (Table 4). There was a statistically significant difference between income manageability and the average amount spent on dietary supplements. Specifically, participants who find it 'difficult all the time' to live on their available household income spend significantly more (mean=\$2963.28) on dietary supplements over 12 months compared to participants who described their income manageability as 'easy or not too bad' (\$1918.56;  $p=0.015$ ). No significant differences were found between who diagnosed their IP and the average amount spent on dietary supplements in the previous 12 months ( $p=0.167$ ). However, participants that were diagnosed by a medical practitioner spent on average \$2309.16 on dietary supplements over the previous 12 months, whereas those who were self-diagnosed spent on average of \$1793.40. Participants on average spent \$286.76 on the assessment of IP with no significant difference found with either income manageability or the source of diagnosis.

There is a statistically significant difference between who diagnosed their IP and the average amount spent on consultation fees in the previous 12 months ( $p<0.001$ ). Specifically, those who were diagnosed by a medical practitioner, or another kind of healthcare practitioner spent significantly more (mean=\$980.63 and \$996.29 respectively) on consultation fees compared to participants who self-diagnosed IP (\$226.45). No difference was found for the average amount spent on consultation fees between a medical practitioner or healthcare practitioners.

### 3.5. Views and preferences towards the costs involved with intestinal permeability

Participants reported that the cost involved in testing IP is 'very important' in their decision to be tested (n=260, 58.8%), with many participants (n=218, 48.8%) indicating they are willing to spend between \$51.00 and \$150.00 on the testing procedure for IP (Table 4). However, the importance of cost in the decision to be tested

decreased as income manageability increased ( $p<0.001$ ). Furthermore, as income manageability increased, so did the amount participants were willing to spend on the testing procedure for IP ( $p<0.001$ ).

Regardless of income manageability, participants reported a preference towards allocating finances to dietary treatment interventions (n=309, 70.6%) for the management of IP followed by dietary supplements (n=265, 60.9%) and lifestyle treatments (n=240, 55.4%) (Table 4). Although half the participants (n=248, 56.5%) reported the financial allocation for the assessment of IP to be 'very important', increased income manageability was associated with the preference towards allocating finances to the assessment of IP ( $p=0.018$ ). Irrespective of income manageability, participants reported medication use to be 'not important' for financial allocation (n=296, 71.6%).

### 3.6. Views and preferences towards the assessment and management of intestinal permeability

The majority of participants (n=527, 89.6%) would prefer to be assessed for IP regardless of income manageability ( $p=0.054$ ) with 75.0% (n=442) reporting the assessment of IP to be 'very important' (Table 5). Accuracy (n=554, 94.9%), accessibility (n=476, 81.4%), and affordability (n=408, 69.5%) were all commonly reported to be 'very important' characteristics for the assessment of IP; whereas non-invasive methods (n=470, 80.6%) and length of time involved to perform the assessment (n=352, 61.1%) were both commonly reported to be 'not important' characteristics for the assessment of IP. Participants further commonly reported the preference to be assessed for IP using blood pathology (n=459, 78.1%) followed by urine collection (n=354, 60.2%) and a stool test (n=325, 44.3%), with a case history assessment by a practitioner (n=242, 41.2%) to be the least preferred method of IP assessment. The time point that participants commonly prefer to be assessed for IP were; before receiving treatment for IP (n=354, 60.1%), for monitoring disease (n=231, 39.2%), when asked by the patient (n=213, 36.2%), for monitoring IP (n=204, 34.6%), after receiving treatment for IP (n=169, 28.7%), when advised by the practitioner (n=160, 27.2%), and during the treatment of IP (n=117, 19.9%).

The majority of participants (n=549, 93.2%) reported they would be 'very likely' to adhere to a treatment protocol if assessed and diagnosed with altered IP (Table 5). In terms of the preferred

**Table 4**  
Expenditures related to the assessment and management of increased intestinal permeability and association with income manageability (n=447)

Expenditures	Mean expenses per person		Income manageability						p-value
			Difficult all the time		Difficult some of the time		Easy or not too bad		
	n	Mean	n	Mean	n	Mean	n	Mean	
<b>Expenses for the management of IP in the previous 12 months</b>									
Consultation fees	424	\$698.78	91	\$903.49	136	\$745.99	197	\$571.62	0.057
Dietary supplements	309	\$2175.96	67	\$2963.28	96	\$2019.36	146	\$1918.56	0.015
<b>Expenses for the assessment of IP</b>									
All assessment methods	74	\$286.76	13	\$238.46	24	\$315.21	37	\$285.27	0.847
Food sensitives - IgG	19	\$515.53	4	\$385.00	4	\$738.75	11	\$481.81	0.746
Stool zonulin	16	\$329.38	4	\$252.50	4	\$500.00	8	\$282.50	0.089
Hemaview - live blood analysis	15	\$204.33	1	\$120.00	8	\$243.13	6	\$166.66	0.620
Iridology	10	\$167.50	3	\$110.00	2	\$100.00	5	\$229.00	0.515
Lactulose/mannitol urine test	9	\$115.00	-	-	4	\$63.75	5	\$156.00	0.030
Kinesiology	4	\$77.50	1	\$100.00	2	\$105.00	1	\$0.00	0.484
Serum zonulin	1	\$70.00	-	-	-	-	1	\$70.00	-
<b>Importance of cost in the decision to be tested</b>									
Very important	260	58.8	72	75.8	94	65.3	94	46.3	<0.001
Important	112	25.3	13	13.7	37	25.7	62	30.5	
Not important	70	15.8	10	10.5	13	9.0	47	23.2	
<b>Amount willing to spend on IP assessment</b>									
\$0-\$50.00	107	23.9	43	45.3	38	26.2	26	12.6	<0.001
\$51.00-\$150.00	218	48.8	41	43.2	67	46.2	110	53.1	
\$151.00 or over	122	27.3	11	11.6	40	27.6	71	34.3	
<b>Preference towards expense allocation to</b>									
<b>Dietary treatments</b>									
Very important	309	70.6	65	70.7	101	70.1	143	70.8	0.953
Important	101	23.1	20	21.7	33	22.9	48	23.8	
Not important	28	6.4	7	7.6	10	6.9	11	5.5	
<b>Dietary supplements</b>									
Very important	265	60.9	53	60.2	90	63.4	122	59.5	0.968
Important	107	24.6	22	25.0	33	23.2	52	25.4	
Not important	63	14.5	13	14.8	19	13.4	31	15.1	
<b>The assessment of IP</b>									
Very important	248	56.5	46	51.7	88	61.1	114	55.3	0.018
Important	117	26.7	18	20.2	39	27.1	60	29.1	
Not important	74	16.9	25	28.1	17	11.8	32	15.5	
<b>Lifestyle treatments</b>									
Very important	240	55.4	58	64.4	78	55.3	104	51.5	0.349
Important	135	31.2	22	24.4	43	30.5	70	34.6	
Not important	58	13.4	10	11.1	20	14.2	28	13.9	
<b>Medications</b>									
Very important	56	13.6	13	15.3	18	13.7	25	12.8	0.841
Important	61	14.8	11	12.9	17	13.0	33	16.8	
Not important	295	71.6	61	71.8	96	73.3	138	70.4	

IP: increased intestinal permeability

method of treating IP, participants ‘strongly prefer’ the use of dietary products (n=392, 82.2%), followed by lifestyle habits (n=357, 76.5%), and dietary supplements (n=324, 68.6%). On the contrary, 82.8% (n=351) of participants ‘slightly prefer’ the use of medications to treat IP, representing the least preferred method of IP treatment.

#### 4. Discussion

This is the first study to describe the health-seeking behaviours and explore the views and preferences of adults with suspected or diagnosed IP. The results of this study suggest inconsistencies between the healthcare provided to Australian adults with suspected IP and the healthcare this patient population would prefer to receive. Most notably, the majority of participants experienced a considerable length of time between first suspecting IP and receiving a diagnosis of IP. They also reported challenges involved in the ac-

curate diagnosis of IP and the out-of-pocket expenditure associated with IP.

##### 4.1. Diagnosis of increased intestinal permeability

Our results indicate that those participants without a formal diagnosis of IP are self-diagnosing; however, have a desire to be assessed using an accurate method by a healthcare practitioner. This discrepancy in the assessment of IP may be contributed in part to the common practices of healthcare practitioners. Practitioners that frequently treat IP in clinical practice avoid measuring IP due to the financial cost to the patient and prioritise case history assessment for diagnosing IP.<sup>18</sup> However, the results of this study suggest that Australian adults with suspected IP are willing to allocate finances to an accurate and accessible method of IP assessment before receiving treatment. The inconsistencies between the healthcare provided to Australian adults with suspected IP and their pre-

**Table 5**  
Views and preferences towards the assessment and management of increased intestinal permeability by Australian adults (n=589)

Views and preferences	Distribution of Responses	
	n	%
<b>Preference to be assessed for IP</b>		
Prefer to be assessed	527	89.6
Prefer not to be assessed	61	10.4
<b>Importance to be assessed for IP</b>		
Very important	442	75.0
Important	78	13.2
Not important	69	11.7
<b>Likelihood of adhering to treatment if assessed and positive for IP</b>		
Very likely	549	93.2
Neutral	23	3.9
Very unlikely	17	2.9
<b>Importance of various assessment characteristics for IP</b>		
<b>Accuracy</b>		
Very important	554	94.9
Important	25	4.3
Not important	5	0.9
<b>Accessibility</b>		
Very important	476	81.4
Important	78	13.3
Not important	31	5.3
<b>Affordability</b>		
Very important	408	69.5
Important	122	20.8
Not important	57	9.7
<b>Time involved</b>		
Very important	113	19.6
Important	111	19.3
Not important	352	61.1
<b>Non-invasive method</b>		
Very important	56	9.6
Important	57	9.8
Not important	470	80.6
<b>Preference of assessment method</b>		
Blood test	459	78.1
Urine collection	354	60.2
Stool test	325	55.3
Case history	242	41.2
<b>Preference for assessment time point</b>		
Before treatment	354	60.1
For monitoring disease	231	39.2
When asked by the patient	213	36.2
For monitoring IP	204	34.6
After treatment	169	28.7
When advised by the practitioner	160	27.2
During treatment	117	19.9
<b>Preference for treatment method</b>		
<b>Dietary products</b>		
Strongly prefer	392	82.2
Prefer	50	10.5
Slightly prefer	35	7.3
<b>Lifestyle habits</b>		
Strongly prefer	357	76.5
Prefer	73	15.6
Slightly prefer	37	7.9
<b>Dietary supplements</b>		
Strongly prefer	324	68.6
Prefer	88	18.6
Slightly prefer	60	12.7
<b>Medication</b>		
Strongly prefer	46	10.9
Prefer	27	6.4
Slightly prefer	351	82.8
<b>Important areas for practitioners to comprehend</b>		
<b>Dietary treatments for IP</b>		
Very important	395	95.2
Important	18	4.3
Not important	2	0.5
<b>Lifestyle treatments for IP</b>		
Very important	389	94.0
Important	23	5.6
Not important	2	0.5

(continued on next page)

Table 5 (continued)

Views and preferences	Distribution of Responses	
	n	%
<b>Signs and symptoms of IP</b>		
Very important	390	93.8
Important	25	6.0
Not important	1	0.2
<b>Biomarkers associated with IP</b>		
Very important	378	91.5
Important	28	6.8
Not important	7	1.7
<b>Risk factors for IP</b>		
Very important	373	90.8
Important	34	8.3
Not important	4	1.0
<b>Methods to accurately assess IP</b>		
Very important	376	90.4
Important	31	7.5
Not important	9	2.2
<b>Conditions associated with IP</b>		
Very important	376	90.2
Important	36	8.6
Not important	5	1.2
<b>Dietary supplements for IP</b>		
Very important	366	89.1
Important	33	8.0
Not important	12	2.9
<b>Time point that IP should be assessed</b>		
Very important	362	87.4
Important	45	10.9
Not important	7	1.7
<b>Individuals that require to be assessed for IP</b>		
Very important	354	85.1
Important	53	12.7
Not important	9	2.2
<b>Medications for IP</b>		
Very important	215	52.4
Important	85	20.7
Not important	110	26.8

IP: increased intestinal permeability

ferred healthcare suggest the preferences of the consumer may not always be considered.

As with other health-related conditions, IP is subject to under-diagnosis, over-diagnosis and misdiagnosis within clinical practice.<sup>22,23</sup> Of particular concern from our findings is the high rate of self-diagnosis of IP. This high self-diagnosis rate may result in a misdiagnosis, causing potential anxiety to the patient, unnecessary treatment burden when not required or result in other more serious health conditions being undiagnosed. The high self-diagnosis rate may also have an overall negative effect on practitioner-patient relationship with the potential utilisation of inaccurate or inappropriate treatments.<sup>24</sup> Our study also revealed that Australian adults with suspected IP would prefer a general practitioner or naturopath to assess them for IP. However, the lack of acknowledgement of IP by medical practitioners<sup>5</sup> may be a driving factor for the large number of Australian adults with suspected IP not receiving a formal diagnosis and a contributing factor as to why it takes 11 years for IP to be diagnosed. Whether the length of time for a formal diagnosis of altered IP is contributed to behaviours of the patient or the practitioner is unknown; however, the shortage of validated testing methods and no gold standard testing method are factors influencing healthcare practitioners not to measure IP and to treat regardless.<sup>18</sup>

A common practice for practitioners is the use of case history in the diagnosis of a number of health conditions, especially functional bowel disorders.<sup>25,26</sup> Even with the extensive algorithms of patients case history, there is still a poor agreement between practitioners and the diagnostic criteria of functional bowel disorders.<sup>27</sup> A concern when applying an algorithmic model of diagnosis to IP

is that there is no validated algorithm and the associated case history features of IP remain uncertain, especially as previously perceived symptoms of IP are not associated with diagnostic markers of IP.<sup>16,18</sup> The clinical similarities between gastrointestinal conditions<sup>26</sup> and the under examined clinical features of IP, limits the accuracy of case history as a diagnostic method for IP.

#### 4.2. Financial expenditure of increased intestinal permeability

The out-of-pocket expenditure associated with the assessment and management of IP suggests a financial burden for Australian adults with suspected IP. Although a financial burden calculation is not possible with the data collected in this study, other Australian based studies provide further support for a potential financial burden. For instance, the mean out-of-pocket expenditure for the assessment and management of suspected IP is similar to the amount spent on chronic health conditions in Australia.<sup>28-30</sup> Furthermore, the out-of-pocket expenditure for consultation fees and dietary supplements over a 12 month period is greater than the mean annual expense for Australian adults with gastrointestinal disorders.<sup>31</sup> As Australia has one of the highest out-of-pocket expenditure for medication in the world,<sup>28,32</sup> healthcare practitioners should consider the out-of-pocket expenses related to IP management, especially people with a low income manageability.

The results of this study suggest a significant difference between the income manageability and the average amount spent on dietary supplements, with those who find it 'difficult all the time' to live on their available household income spending significantly more on dietary supplements compared to the 'easy or not

too bad' income groups. Other studies suggest people with poor financial status are more likely to face a financial burden in relation to the out-of-pocket expenditure.<sup>29,33</sup> Whether a person's income manageability is a cause or consequence for the out-of-pocket expenditure on IP remains unknown; however, is a worthy area for further investigation.

#### 4.3. Views and preferences of increased intestinal permeability

The results of this study suggest that Australian adults with suspected IP place little importance or value on medication use for the treatment of IP. The strong aversion towards medication use highlights a potential barrier for future pharmacological treatments under development.<sup>34,35</sup> Whether Australian adults with suspected IP will use such medication remains an area for future research. However, what this study does suggest is dietary products (dietary interventions) are the preferred method for the treatment of IP. Dietary interventions are also the most frequently used type of treatment for IP by practitioners in Australia,<sup>17</sup> highlighting agreement between the preferred treatment method for IP and the care given by healthcare practitioners. Utilising the results of this study, patients' views and preferences can help inform the development of a clinical practice guideline for the assessment and management of IP.

#### 4.4. Limitations

There are a number of potential limitations of our study that need to be considered when interpreting our findings. Our sample has a greater percentage of females than the Australian general population, hence caution is required if generalising findings to the Australian population. Although this study aimed to explore Australian adults with suspected IP, whether or not participants have diagnosed IP is unknown. Therefore, these results are more relevant to those who suspect they have IP rather than those with a confirmed diagnosis. Self-reported data collection has the potential for recall bias. However, as this was the first survey to describe the health-seeking behaviours of Australian adults with suspected IP, this study does provide new and important information, thus advancing the research agenda on this topic.

#### 4.5. Conclusion

The investigation of Australian adults with suspected IP has highlighted major inconsistencies between the healthcare provided and the healthcare this patient population would prefer to receive, especially regarding the diagnosis of IP. Most notably, the majority of participants experienced a considerable length of time between first suspecting IP and receiving a diagnosis of IP. The out-of-pocket expenditure associated with the assessment and management of IP suggests a financial burden for people with suspected IP. The results of this study provide novel patient-centred considerations that can be used to inform a clinical practice guideline for the assessment and management of IP as an important public health initiative.

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#### Author contributions

Conceptualization: BL, EM, AS, and DS. Methodology: BL, EM, AS, and DS. Investigation: BL, EM, AS, and DS. Formal analysis: BL, EM, AS, and DS. Writing – original draft: BL. Writing – review & editing: BL, EM, AS, and DS.

#### Conflict of interest

The authors declare that they have no conflict of interests.

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#### Ethical statement

This study was approved by the Human Research Ethics Committees (HREC) of the University of Technology Sydney (#ETH19-4012).

#### Data availability

Data associated with this study will be available upon request.

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