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### Effects of dairy products on Crohn's Disease symptoms are influenced by fat content and disease location but not lactose content or disease activity status in a New Zealand population

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# Effects of dairy products on Crohn's Disease symptoms are influenced by fat content and disease location but not lactose content or disease activity status in a New Zealand population

## Abstract

**Background** Dairy products have been perceived as having the potential to cause adverse effects in individuals with Crohn's disease (CD) and are often avoided, potentially increasing the risk of osteoporosis and related morbidity associated with inadequate dietary calcium intake. **Objective** To evaluate the self-reported effects of dairy products on CD symptoms and to determine whether these effects differed between types of dairy products consumed and disease state or location. **Design** Secondary analysis of dietary survey and clinical data from participants in the Genes and Diet in Inflammatory Bowel Disease study based in Auckland, New Zealand. **Subjects/setting** One hundred and sixty-five men and women diagnosed with CD for which both dietary survey data and clinical information were available. **Statistical analyses performed** 2 analysis was conducted to assess whether significant differences in the proportions of responses relating to a worsening of CD symptoms from individual dairy products were evident between individuals with active or quiescent CD, or ileal or colonic disease locations. Odds ratios with confidence interval were calculated to determine whether CD location was associated with risk of any type of adverse reaction to milk products. Logit scales were utilized to depict self-reported CD symptoms associated with individual dairy product consumption for ileal and colonic CD patients. **Results** Dairy products had no effect on self-reported CD symptoms for most people. Dairy products with a high fat content were most frequently reported to worsen perceived CD symptoms. Clinically, self-reported CD activity status did not influence responses to dairy products; however, colonic inflammation was more frequently associated with adverse CD effects in comparison to ileal CD involvement. **Conclusions** Research outcomes question the necessity of dairy product avoidance in CD patients and illustrate the highly individual nature of dairy product tolerance in this clinical population

## Keywords

but, zealand, location, content, fat, influenced, symptoms, disease, crohn, products, dairy, effects, status, activity, lactose, not, population

## Disciplines

Arts and Humanities | Life Sciences | Medicine and Health Sciences | Social and Behavioral Sciences

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1 **Effects of dairy products on Crohn's Disease symptoms are influenced by fat content**  
2 **and disease location but not lactose content or disease activity status in a New Zealand**  
3 **population**

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20 **Effects of dairy products on Crohn's Disease symptoms are influenced by fat content**  
21 **and disease location but not lactose content or disease activity status in a New Zealand**  
22 **population**

### 23 **Background**

24 Dairy products have been perceived as having the potential to cause adverse effects in  
25 individuals with Crohn's Disease (CD) and are thus often avoided, potentially increasing the  
26 risk of osteoporosis and related morbidity associated with inadequate dietary calcium intake.

### 27 **Objective**

28 To evaluate the self reported effects of dairy products on CD symptoms and to determine  
29 whether these affects differed between types of dairy products consumed and disease state or  
30 location.

### 31 **Design**

32 Secondary analysis of dietary survey and clinical data from participants in the 'Genes and  
33 Diet in Inflammatory Bowel Disease' study based in Auckland, New Zealand.

### 34 **Subjects/setting**

35 One hundred and sixty five men and women diagnosed with CD that had both dietary survey  
36 data and clinical information available.

### 37 **Statistical analyses performed**

38 Chi Squared analysis was used to assess whether significant differences in the proportions of  
39 responses relating to CD symptoms and dairy products were evident. Odds ratios with  
40 confidence interval were calculated to determine whether CD location was associated with

41 the risk of adverse reactions to milk products. Logit scales were utilised for depiction of  
42 reported CD symptoms associated with individual dairy product consumption.

### 43 **Results**

44 Dairy products had no effect on CD symptoms for most people. The greatest proportions of  
45 adverse affects were seen for dairy products with a high fat content. Clinically, CD activity  
46 status did not influence responses to dairy products; however colonic inflammation was more  
47 frequently associated with adverse CD effects in comparison to ileal CD involvement.

### 48 **Conclusions**

49 Research outcomes question the necessity of dairy product avoidance in CD patients and  
50 illustrate the highly individual nature of dairy product tolerance in this clinical population.

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62 Crohn's Disease (CD) is a debilitating form of inflammatory bowel disease which can affect  
63 any location of the gastrointestinal tract resulting in considerable morbidity (1). The  
64 incidence of CD in a New Zealand based epidemiological study was 16.5/100,000 per year,  
65 (2), higher than in many Western Countries and thus affecting a significant proportion of the  
66 New Zealand population.

67 Dairy products have often been perceived as having the potential to cause adverse effects in  
68 individuals with CD and are thus often avoided, potentially increasing the risk of osteoporosis  
69 and related morbidity associated with inadequate dietary calcium intake.

70 There are several hypotheses proposed to explain this perceived adverse affect. Perhaps the  
71 most frequently reported theory relates to the prevalence of lactose intolerance in CD  
72 patients. A higher prevalence of lactose malabsorption as diagnosed by hydrogen breath  
73 testing, in individuals with CD has been reported in comparison to controls (3). Allergy to  
74 major milk proteins may be a further reason that a small number of CD patients report  
75 adverse affects from dairy products (4). Additionally, individuals with CD may be  
76 susceptible to secondary lactose intolerance. During the periods of the acute gastrointestinal  
77 inflammation characteristic of CD, quantities of the lactase, the lactose digesting enzyme,  
78 may decline in the duodenal mucosa, resulting in the gastrointestinal discomfort associated  
79 with lactose maldigestion (5). Thus disease state (active or quiescent) may affect response to  
80 dairy products in this clinical population.

81 The disease location may further influence tolerance to dairy products in individuals with  
82 CD. As lactase is located within small intestinal villi, this is the primary site of lactose  
83 digestion (6). Thus individuals with inflammatory disease located within this region of the  
84 gastrointestinal tract may have difficulties with lactose intolerance and thus perceive that  
85 adverse CD symptoms are associated with consumption of dairy products.

86 The aim of this study was to evaluate the self reported effects of dairy products on CD  
87 symptoms and to determine whether these affects differed between types of dairy products  
88 consumed, disease state or location. The identification of dairy mediated affects on CD  
89 symptoms may facilitate the provision of more targeted dietary advice on dairy products for  
90 this clinical population.

## 91 **Methods**

92 This study was based on a secondary analysis of dietary survey and clinical data from 165  
93 adults with CD. All subjects were Caucasian participants in the ‘Genes and Diet in  
94 Inflammatory Bowel Disease’ study based in Auckland, New Zealand (7). Subjects were  
95 selected on the basis that a complete set of dietary and clinical data was available.

96 The ‘Genes and Diet in Inflammatory Bowel Disease’ study was approved by the New  
97 Zealand Multi-Region Human Ethics Committee (MEC/04/12/011). Access to the data for  
98 this secondary analysis met ethical approval and all information utilised was coded to protect  
99 the anonymity of participants.

## 100 **Clinical Data**

101 Clinical information including age, IBD diagnosis and latest Montreal classification  
102 illustrating latest CD location (8) was provided following evaluation of patient medical notes  
103 and secondary patient investigation by an experienced gastroenterologist as a part of the  
104 ‘Genes and Diet in Inflammatory Bowel Disease’ study. Individuals with a latest Montreal  
105 classification of L1, indicating ileal involvement, were grouped into the ‘ileal involvement’  
106 group. While individuals with a classification of L2, indicating isolated colonic involvement,  
107 were classified as the ‘colonic involvement’ group. For simplicity individuals with a  
108 classification of L3 and L4 (indicating ileocolonic and upper gastrointestinal disease in the

109 presence of classifications of L1-L3 respectively (9) were excluded from this part of the  
110 analysis.

111 Additional clinical information was sought from the dietary questionnaire whereby subjects  
112 reported current disease activity status (active or quiescent).

### 113 **Assessment of affects of individual dairy products**

114 For the purpose of this study dairy products were categorised to include ruminant milk  
115 (inclusive of sheep, cow and goat varieties), yoghurt, butter, custard, ice cream, cream and  
116 cheese.

117 Self reported data on effects of dairy products were extracted from a dietary questionnaire,  
118 which required participants to nominate whether particular foods items made their IBD  
119 conditions either: 'definitely worse', 'probably worse', 'had no effect', 'probably better' or  
120 'definitely better'. Subjects reporting that particular dairy products made their condition  
121 either 'definitely' or 'probably worse' were categorised as having an adverse reaction to that  
122 food. Similarly those reporting a 'definitely' or 'probably better' effect of a particular dairy  
123 product on their CD condition were categorised as having a beneficial effect from consuming  
124 that food. This dietary questionnaire is described in more detail elsewhere (7). Several open  
125 ended questions within the dietary questionnaire were also analysed to determine qualitative  
126 information regarding perceived effects on CD condition associated with particular dairy  
127 products. These questions included:

- 128 • *Is there a difference with the type of cheese eaten? If so, please outline:*
- 129 • *Is there a difference with the type of yoghurt eaten? If so, please outline:*



130 Both quantitative and qualitative information about the frequency and nature of adverse  
131 reactions to milk products was extracted from this supplementary questionnaire following an  
132 analysis of open ended questions including:

- 133 • *Have you ever had an adverse reaction to a milk product?*
- 134 • *What were your adverse symptoms after consuming milk products?*
- 135 • *Have you seen a health professional about your reactions to milk products (if*  
136 *applicable)?*
- 137 • *Have you been formally diagnosed with an intolerance or allergy?*

### 138 **Data Analysis**

139 Qualitative data (including reports on symptoms of adverse reactions to dairy products and of  
140 symptomatic differences from different types of dairy products consumed) was categorised  
141 accordingly and the proportion of individuals responding to each category was calculated.

142 Chi Squared analysis was conducted to assess whether significant differences in the  
143 proportions of responses relating to CD symptoms and dairy products were evident. Odds  
144 ratios with confidence interval were calculated to determine whether CD location was  
145 associated with the risk of adverse reactions to milk products. Results were considered  
146 statistically significant at  $p < 0.05$ .

147 For interpretation of data grouped by disease location (ileal vs. colonic), logit scales were  
148 utilised to create a clear visual representation of reported CD symptoms associated with  
149 consumption of individual dairy products whilst addressing the issue of the variance of  
150 proportions between the groups.

151 All analyses were conducted using SPSS (V15.0 1989-2006, SPSS Inc., Chicago II, USA), R  
152 (R Development Core Team (2009). R: A language and environment for

153 Statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-  
154 900051-07-0, URL <http://www.R-project.org.ref>) and SAS (V9.1 SAS Institute., Cary, NC,  
155 USA) statistical software packages.

## 156 **Results**

157 Dietary and clinical data was available for 165 patients with CD, (mean age  $48.8 \pm 16.3$ ). The  
158 study sample was predominantly female, (males  $n=49$ , mean age  $50.6 \pm 17.8$ ), females  $n=116$   
159 (mean age  $48.0 \pm 15.6$ ).

### 160 *Clinical Profiles*

161 Of the study sample, 80 patients (48.5%) reported that their CD was currently active and 82  
162 (49.7%) identified their CD as being in the quiescent phase. Three patients did not answer  
163 this survey question. There was no difference between the sexes in the proportion reporting  
164 an active CD period at the time of survey completion ( $\chi^2 = 0.38$ ,  $p = 0.54$ ).

165 Data was available for 160 patients on the latest Montreal classifications indicating the  
166 location of CD. Isolated ileal disease involvement was present for 32.7% of the study sample,  
167 while 27.9% displayed evidence of isolated colonic involvement (Table 1).

168 There was no significant difference between males and females in terms of CD location ( $\chi^2 =$   
169  $0.98$ ,  $p = 0.81$ ).

### 170 *Effects of Dairy products on CD symptoms*

171 Forty two participants (25.5%) reported having an adverse reaction to a product containing  
172 milk, whilst 111 (67.3%) felt that they had no experience of an adverse event with milk  
173 product consumption. Of patients reporting an adverse reaction associated with a milk

174 product, 24 (61.5%) of those reported that the reaction was persistent, while 7 individuals  
175 (4.2%) felt that it was an isolated event.

176 A formal diagnosis of lactose intolerance was reported for 11 patients (6.7% of the study  
177 population). A total of 41 CD patients described adverse symptoms experienced following  
178 consumption of milk products (Figure 1).

179 As an aside to this data, naturopaths were the listed as the health practitioner most frequently  
180 sought for advice regarding adverse affects to dairy products (n=9), specialist consultants  
181 including gastroenterologists and allergy specialists were the next most frequently sought  
182 (n=8), followed by general practitioners (n=7). Only one individual reported seeking advice  
183 in relation to dairy product intolerance from a dietitian.

#### 184 *Reported associations between dairy product consumption and CD symptoms*

185 No effect on CD symptoms was reportedly associated with consumption of butter, standard  
186 cow's milk and reduced fat cow's milk in 71.5%, 64.2% and 58.2% of all patients  
187 respectively. Dairy products most frequently reported as associated with worsening CD  
188 symptoms were cream (43.6%), ice cream (37.6%) and cheese (34.5%). Conversely, yoghurt,  
189 the dairy product most frequently perceived as beneficial was reported by 14.5% of  
190 individuals as having favourable effects on CD symptoms. The response to this question was  
191 quite varied (Table 2).

#### 192 *Cheese*

193 When asked whether the type of cheese may influence CD symptoms, 26.1% of participants  
194 reported positively. The flavour strength of the cheese was most frequently reported as  
195 influencing tolerance, with 15 patients reporting that increased strength cheese decreased  
196 tolerance. Richer/soft cheeses were reported to increase adverse affects for 9 patients, with a

197 preference for Feta and Edam cheese varieties reported by 8 and 7 patients respectively.  
198 Cheeses with a lower fat content were reported to increase tolerance (n= 6) as did hard  
199 cheeses (n=5) and plain cheeses without added herbs (n= 3). Melted cheese was associated  
200 with an increase in adverse effects for 4 CD patients.

#### 201 *Yoghurt*

202 In total 23.0% of respondents reported that the type of yoghurt consumed may also be a key  
203 factor relating to whether it would be tolerated. Patients reported that yoghurts containing  
204 live cultures such as acidophilus were most beneficial to CD symptoms (n=19), whilst natural  
205 yoghurt was preferable to sweetened alternatives for 11 patients. A preference for reduced fat  
206 yoghurt was reported (n=9), with yoghurt lacking seeds or fruit preferred by a further 4.8%  
207 (n=8) of individuals.

#### 208 *Disease Activity and effect of dairy products on CD symptoms*

209 There were no significant differences in the proportion of dairy product mediated CD  
210 symptoms between patients in the active or quiescent CD state (Table 3).

#### 211 *Site of Disease and effect of dairy products on CD symptoms*

212 Likewise, no significant differences were detected between CD symptoms from individual  
213 dairy products and ileal or colonic disease location (data not shown). However, significantly  
214 more patients with colonic disease activity reported ever having an adverse reaction to dairy  
215 products compared to those with ileal disease ( $\chi^2=5.90$ ,  $p=0.015$ ), (OR = 0.32, 95% CI =  
216 (0.13-0.82),  $p=0.017$ )).

217 Logit scales of adverse and beneficial CD effects from individual dairy products in  
218 individuals with either small intestinal (ileal) or colonic CD involvement are displayed in  
219 figures 2(a) and (b). Only dairy products with at least one reported beneficial/ adverse effect

220 on CD symptoms can be plotted with the Logit scale. Thus for patients with ileal  
221 involvement butter, Goat and Sheep milk were not included in the Logit graph. Similarly,  
222 cream, ice cream, sheep and goat milk were not graphed for individuals with colonic  
223 involvement.

224

## 225 **Discussion**

226 The analysis of self reported effects of consuming dairy products on CD symptoms has  
227 clearly illustrated the extent of variation in tolerance to dairy products within this clinical  
228 population.

229 Most importantly, the majority of the study sample reported that consumption of dairy  
230 products made no difference to CD symptoms. This finding reinforces the need to determine  
231 tolerance to dairy products in CD patients prior to encouraging widespread avoidance of this  
232 food group, an idea that may be still encouraged by some physicians and many alternative  
233 health consultants. Whilst it may be pertinent to avoid some dairy products for CD patients  
234 with congenital hypolactasia or during periods of active disease, unnecessary avoidance of all  
235 dairy products by this clinical group without appropriate nutrition support may have  
236 deleterious consequences. Individuals with CD are more susceptible to osteoporosis (10).  
237 Prolonged corticosteroid utilisation to induce remission of inflammation has been  
238 demonstrated to reduce bone mineral density (BMD) in CD patients (11). CD itself may be an  
239 independent risk factor for osteoporosis (12) with an increase in pro- inflammatory cytokines  
240 associated with disease pathogenesis mediating excessive bone resorption (13). According to  
241 the National New Zealand Nutrition Survey (14) milk, cheese and other dairy products were  
242 the highest food contributors of dietary calcium in the New Zealand population, contributing  
243 37%, 11% and 5% of total calcium consumed respectively. While evidence is conflicting,

244 Abitbol and colleagues (15) demonstrated a protective effect of calcium intake on BMD in  
245 individuals with inflammatory bowel disease, and increased dairy products consumption has  
246 been reported to retard bone loss (16). Thus, eliminating dairy products as the highest  
247 contributor of dietary calcium from the diet may further exacerbate risk of osteoporosis and  
248 related morbidity in individuals with CD in New Zealand.

249 Intermittent secondary lactose intolerance may be experienced by some individuals with CD  
250 during periods of active gastrointestinal inflammation (5). Formally diagnosed lactose  
251 intolerance was reported for only a small proportion of the study sample. However, in our  
252 study, symptoms consistent with lactose maldigestion, including bloating, diarrhoea and gas  
253 (17), were the most frequently reported adverse effect associated with milk product  
254 consumption. This finding indicates that secondary lactose intolerance may have influenced  
255 the response to dairy products for a greater number of this CD study sample.

256 Seeking assistance from alternative health practitioners is a practice frequently observed in  
257 individuals suffering from inflammatory bowel conditions (18). Advice of this nature is often  
258 sought as an adjunct to conventional medical therapies in an effort to establish a sense of  
259 control over this debilitating condition (19). This practice was evident in our clinical  
260 population whereby naturopaths were the most frequently utilised source of advice regarding  
261 issues with dairy product tolerance. Ensuring accurate advice in relation to dairy product  
262 consumption is imperative to prevent micronutrient deficiencies in this clinical population.  
263 Appropriate dietetic intervention is instrumental to ensuring optimal BMD in patients with  
264 CD (20). Thus, for individuals reporting adverse CD effects associated with dairy products,  
265 dietetic intervention should be encouraged as part of the continuum of care.

266 In our study sample, tolerance for individual dairy product tolerance was highly variable. In  
267 fact, the majority of individuals experienced no effect on CD symptoms associated with each

268 of the individual dairy products under question. An exception to this finding was evident for  
269 cream, with the highest proportion of individuals in the study sample reporting adverse CD  
270 symptoms associated with its consumption. The perceived adverse affects may relate to the  
271 high fat content of this item. High dietary fat intakes decrease gastric emptying rates (21). In  
272 addition, disorders in gastrointestinal motility have been observed in this clinical population,  
273 with affected individuals more likely to experience gastric hypomotility than controls (22).  
274 Thus effects of dietary-fat mediated gastroparesis following consumption of dairy products  
275 rich in fat may be more pronounced in individuals with CD. Symptoms of gastroparesis  
276 include nausea; abdominal pain and bloating (23) all of which were frequently reported as  
277 adverse affects following dairy product consumption in our study.

278 Other dairy products containing higher amounts of fat including ice cream, cheese and  
279 standard cow's milk were associated with larger proportions of worsening CD symptoms in  
280 comparison to lower fat dairy counterparts. Furthermore, reduced fat cheese and yoghurt  
281 varieties were perceived as more tolerable. These findings illustrate that the fat content of  
282 dairy products may be a key factor influencing tolerance in this clinical population.

283 Of interest we found, that butter, a dairy product that contains a very high proportion of fat,  
284 was not reported as having adverse effects on CD symptoms for the majority of individuals. It  
285 may be that butter is not being consumed in amounts great enough to influence gastric stasis  
286 in the study sample. Conversely, butter contains a relatively high proportion of conjugated  
287 linoleic acid (CLA). CLA has been implicated in the amelioration of inflammation in  
288 experimental models of IBD, particularly in relation to colitis (24). Thus the lack of adverse  
289 effects on CD symptoms associated with butter consumption may be the result of this CLA  
290 mediated anti-inflammatory effect.

291 Probiotic –containing yoghurt has been demonstrated to attenuate markers of inflammation in  
292 individuals with inflammatory bowel disease (25) and the dairy product most frequently  
293 associated with having a beneficial effect on CD symptoms in our study was yoghurt.  
294 However, we found yoghurt to also be associated with a worsening of CD symptoms for a  
295 slightly greater proportion of individuals than had experienced beneficial effects from it. A  
296 limitation of the survey which we utilised for analysis was that it failed to distinguish  
297 between CD effects experienced from probiotic yoghurt and non-probiotic varieties. An  
298 analysis of qualitative responses indicated that for individuals experiencing a difference in  
299 CD symptoms dependent on the type of yoghurt consumed, those containing live cultures and  
300 probiotics were most frequently associated with beneficial effects. Thus probiotic yoghurts  
301 appeared to benefit individuals with CD in preference to yoghurt without live cultures;  
302 however this is an area that requires further research.

303 It was expected from previous observations (7) that goat and sheep milk may result in less  
304 adverse CD effects than their bovine counterparts. Goat milk in particular contains  
305 oligosaccharides which have demonstrated anti-inflammatory effects in rat models of  
306 inflammatory bowel disease (26). In addition sheep and goat's milk contain higher  
307 proportions of medium chain triglycerides than cow's milk which may enhance digestibility  
308 (27). Finally, like butter, sheep milk contains relatively high amounts of CLA (28) which  
309 may further ameliorate gastrointestinal inflammation (24). In our study, only a very small  
310 proportion of individuals reported a beneficial CD effect associated with consumption of  
311 these milk products, with a slightly greater proportion reporting adverse affects. However,  
312 because the majority of individuals did not answer this question, indicating that they did not  
313 consume these items, it was not possible to determine the true effect of goat and sheep milk  
314 on CD symptoms. Given emerging evidence to suggest a potentially beneficial role for sheep



315 and goat milks in relation to CD symptoms, evaluating the true effects of these products may  
316 be an important area for future research.

317 The lactose content of the individual dairy products did not seem to influence CD symptoms  
318 in our study sample. Cow's milk, which contains a significantly greater amount of lactose per  
319 serve than cream, ice cream or cheese (17) was associated with comparatively less symptom  
320 worsening. Additionally, lactose tolerance may be influenced by gastrointestinal transit time,  
321 with higher fat milk products travelling less rapidly throughout the small intestine, affording  
322 lactase a greater opportunity for lactose digestion (17). Thus, if lactose was a key factor  
323 relating to CD symptoms in our study sample, reduced fat cow's milk would have been  
324 associated with less favourable CD effects than its standard variety. As this was not the case  
325 it appears that the lactose content of individual dairy products does not have a major impact  
326 on CD symptoms. In contrast, qualitative responses regarding the types of cheese and  
327 yoghurt consumed that may affect tolerance indicate a lactose effect in a small proportion of  
328 the study sample. The preference for yoghurt containing live bacteria previously outlined  
329 may be associated with tolerance to lactose for some individuals, given that these organisms  
330 perform the activity of lactase (29), enhancing digestibility. Similarly several individuals  
331 reported a preference for hard cheeses such as cheddar in comparison to soft cheeses. Hard  
332 cheeses may contain slightly less lactose than soft varieties such as cream cheese (17) and  
333 may thus be better tolerated by individuals with lactose digestion issues.

334 In our study disease activity (active vs. quiescent) did not appear to influence perceived  
335 effects of dairy products on CD symptoms, with a similar proportion of individuals reporting  
336 either adverse or beneficial dairy mediated CD effects irrespective of disease activity. This  
337 finding challenges the necessity of dairy avoidance during active CD. However, as disease  
338 activity was subjectively reported, these findings should be interpreted with caution.

339 Reference to the logit scales developed in our analysis shows that individuals with isolated  
340 colonic inflammation appeared to have an increase in adverse CD symptoms from consuming  
341 reduced fat cow's milk, custard, sheep's milk and yoghurt was evident in the logit scales in  
342 comparison to those with isolated small intestinal (ileal) involvement. This was an  
343 unexpected finding as it was anticipated that individuals with small intestinal inflammation  
344 would be more likely to have issues with lactose and thus dairy product tolerance, given that  
345 lactase lines the small intestinal mucosa (6). Furthermore Annese et al (22) reported most  
346 severe gastrointestinal motility disorders occur in Crohn's ileitis. This unexpected finding  
347 warrants further investigation and may relate to functional differences in gut microbiota  
348 amongst individuals with CD affecting varied locations throughout the gastrointestinal tract.

349 A possible explanation for the unexpected outcomes observed in relation to dairy product  
350 tolerance in this study may be attributable to individual genetic variation. Although clear  
351 genomic loci such as NOD2 and IL23R have been repeatedly associated with this CD in  
352 genome wide association studies (30), there is a paucity of evidence in relation to genetic  
353 factors that may influence tolerance to dairy products in individuals with this inflammatory  
354 condition. Future research efforts should consider the impact of genetic interactions on dairy  
355 product tolerance in CD to conclusively address the research question.

356 This study is limited by the subjective nature of the dietary questionnaire utilised, and the  
357 relatively small size of the CD sample that make it difficult to extrapolate findings to the  
358 wider Crohn's disease community. However, to our knowledge, this is the first study to  
359 assess the perceived affects of dairy products on CD symptoms taking into account both  
360 clinical and qualitative data.

361

362

363 **Conclusion**

364 In conclusion, within our study sample of CD patients in Auckland, New Zealand, dairy  
365 products in general had no effect on CD symptoms for most people. When analysed  
366 according to type of dairy product, the greatest proportion of adverse affects were seen for  
367 products with a high fat content. The lactose content of individual dairy products did not  
368 influence perceived affects on CD symptoms for the majority of patients. Clinically, CD  
369 activity status did not influence responses to dairy products; however site of disease appeared  
370 to have an effect. Colonic inflammation was more frequently associated with an increase in  
371 reported adverse CD effects from dairy product consumption in comparison to ileal CD  
372 involvement. Results from this exploratory study reinforce the idea that that ‘one size does  
373 not fit all’ when it comes to making dietary recommendations relating to dairy product  
374 consumption for individuals with Crohn’s Disease. Future research should consider the  
375 identification of genetic variants that may further explain tolerance to dairy products in this  
376 clinical population.

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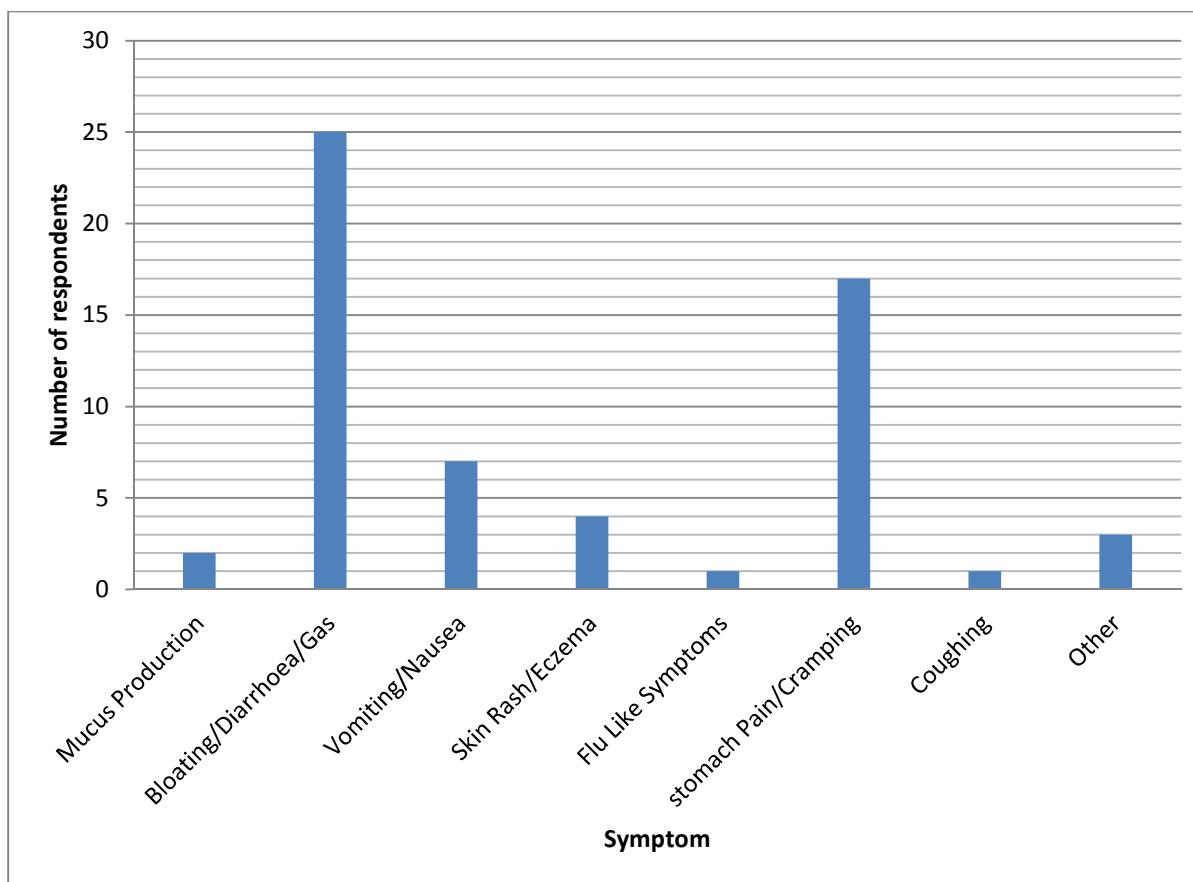
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**Table 1. Latest subject Montreal classifications for location of CD (n=160)**

<b>Montreal classification for CD location</b>	<b>Group: n (%)</b>	<b>Males: n (%)</b>	<b>Females: n (%)</b>
L1 – Ileal	54 (32.7%)	14 (28.6%)	40 (34.5%)
L2 - Colonic	46 (27.9%)	16 (32.7%)	30 (25.9%)
L3 Ileocolonic	51 (30.9%)	15 (30.6%)	36 (31.0%)
L4 – Isolated upper disease	9 (5.5%)	3 (6.1%)	6 (5.2%)





**Figure 1. Adverse symptoms reported by CD patients following consumption of dairy products (n=41)\***

\*Some patients reported more than 1 symptom. Other adverse symptoms reported include: asthma (n=1), reflux (n=1), bowel irritation (n=1) and inflammation (n=1).

**Table 2. Self-reported effect of individual dairy products on CD symptoms (n=165)**

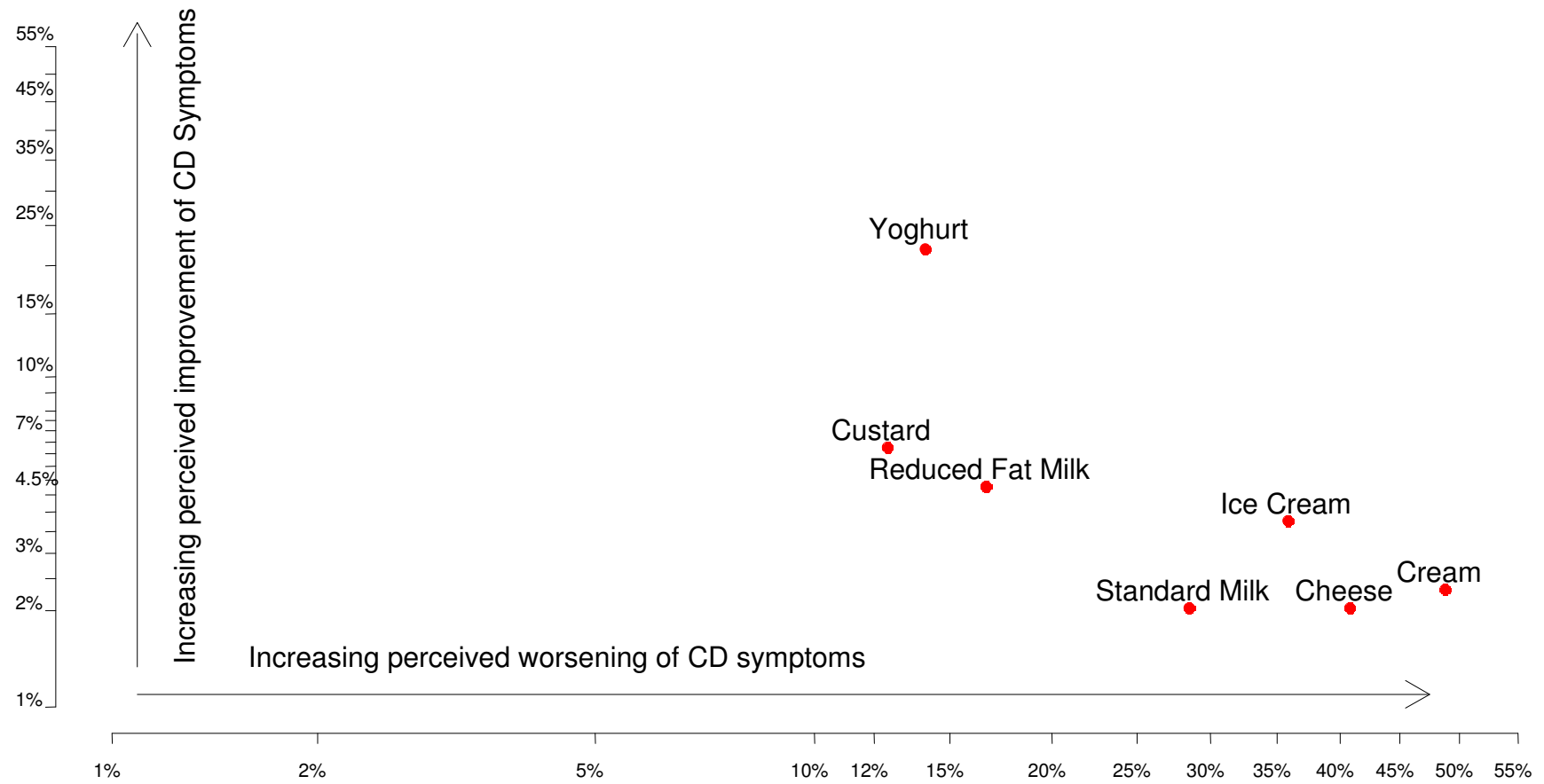
<b>Food Item</b>	<b>CD Symptoms Worse N (%)</b>	<b>No difference to CD symptoms N (%)</b>	<b>CD Symptoms better N (%)</b>	<b>Question not answered N (%)</b>
Standard Cow's Milk	51 (30.9%)	91 (55.2%)	2 (1.2%)	21 (12.7%)
Reduced Fat Cow's Milk	30 (18.2%)	96 (58.2%)	10 (6.0%)	29 (17.6%)
Butter	29 (17.6%)	118 (71.5%)	2 (1.2%)	16 (9.7%)
Custard	32 (19.4%)	106 (64.2%)	8 (4.8%)	19 (11.5%)
Goat's Milk	11 (6.7%)	27 (16.4%)	4 (2.4%)	123 (74.5%)
Sheep's Milk	11 (6.7%)	27 (16.4%)	5(3.0%)	122 (73.9%)
Ice Cream	62 (37.6%)	94 (57.0%)	3 (1.8%)	6 (3.6%)
Yoghurt	31 (18.8%)	94 (57.0%)	24 (14.5%)	16 (9.7%)
Cheese	57 (34.5%)	95 (57.6%)	5 (3.0%)	8 (4.8%)

Cream	72 (43.6%)	72 (43.6%)	1 (0.6%)	20 (12.1%)
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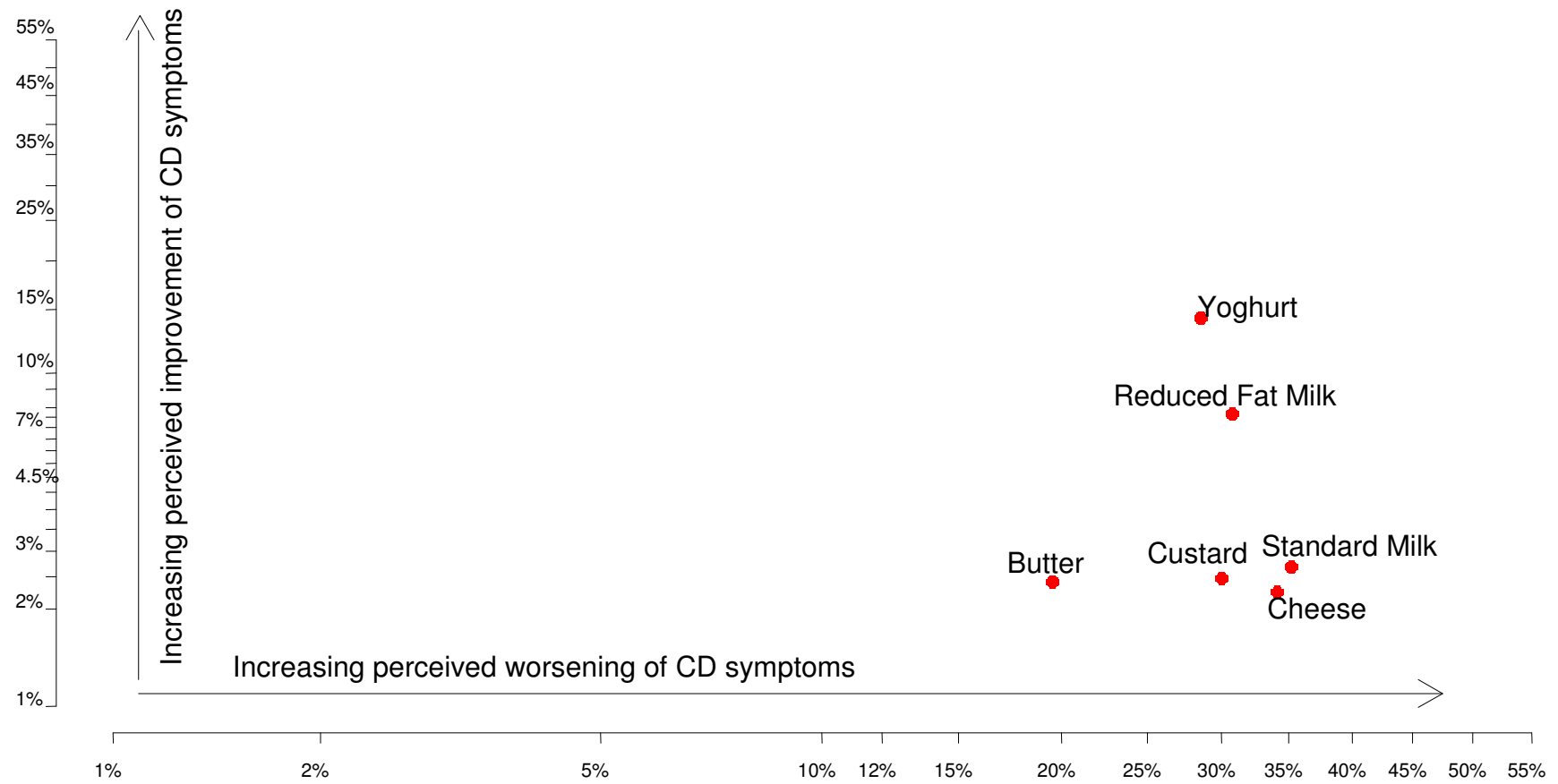
**Table 3. Self-reported effect of individual dairy products on worsening CD symptoms analyzed by disease activity status (n=162)**

Food Item	CD Symptoms		No difference to		Chi Squared Analysis
	Worse n (%)		CD symptoms n (%)		
	Active CD (n=80)	Quiescent CD (n= 82)	Active CD (n=80)	Quiescent CD (n= 82)	
Standard Cow's Milk	21	30	45	43	( $\chi^2 = 1.28$ , p= 0.26)
Reduced Fat Cow's Milk	14	15	46	48	( $\chi^2 = 0.004$ , p = 0.95)
Butter	15	9	57	61	( $\chi^2 = 1.61$ , p= 0.20)
Custard	17	14	50	54	( $\chi^2 = 0.48$ , p= 0.51)
Goat's Milk	7	4	13	13	( $\chi^2 = 0.58$ , p= 0.45)
Sheep's Milk	5	6	13	13	( $\chi^2 = 0.64$ , p= 0.80)

Ice Cream	31	30	45	47	( $\chi^2 = 0.053$ , p= 0.82)
Yoghurt	16	14	46	47	( $\chi^2 = 0.14$ , p= 0.71)
Cheese	27	29	46	47	( $\chi^2 = 0.02$ , p= 0.883)
Cream	36	36	35	35	( $\chi^2 = 0.00$ , p= 1.00)



**Figure 2(a). Self-reported effects of individual dairy products on CD symptoms for individuals with ileal disease involvement.**



**Figure 2(b). Self-reported effects of individual dairy products on CD symptoms for individuals with colonic disease involvement**