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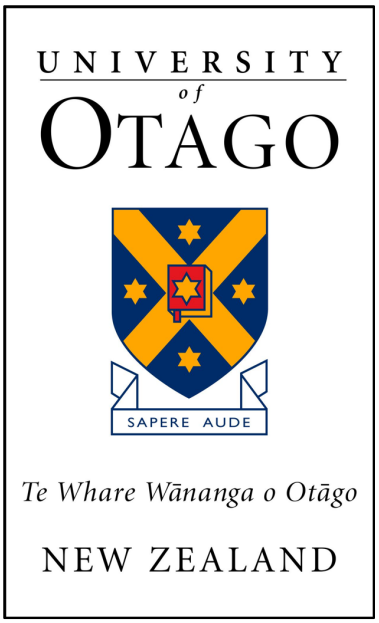

Health Infographics to Communicate Dietary Information for Colorectal Cancer Prevention

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Abstract

Currently, Colorectal Cancer (CRC) is the world's third most common cancer. By 2030 the incidence of CRC is expected to increase by an additional 2.2 million new cases and 1.1 million deaths yearly. This increase is partly due to the lack of dietary information for people at risk. This thesis aimed to design and assess the effectiveness of animated and static infographics to communicate dietary information for CRC prevention. This thesis has a creative component and an academic component. The creative component involved designing four static infographics through Adobe Illustrator Creative Cloud (ICC) and animating them through Apple Keynote (leading to a total of eight infographics). The academic component used multiple-choice survey questions to test the knowledge of participants after viewing either one the static or animated infographic. A score out of nine was given to each participant, and average scores were compared between groups. The surveys asked demographics (age and ethnicity) questions along with any previous experience of CRC to observe which groups could recall the information presented in the infographics better. Additionally, infographic content was also analysed by comparing risk-based information against protective information to see which is more beneficial.

A total of 1,011 participants completed the surveys. No differences were observed between animated and static infographics. However, infographics displaying negative risk information were better recalled by participants than protective information. The 18 – 29 age group showed the lowest average score compared to the older age groups and respondents of Indian origins showed a lower average score compared with the Europeans and North Americans. Interestingly, while participants who have knowledge of CRC scored a higher average score compared to individuals who have not, individuals who are not connected to anyone with CRC scored a higher average score compared to individuals who were associated with someone with CRC.

In conclusion, infographic designers for CRC prevention should focus more on the infographic content than on the type of infographic used for communication. Infographics should continue to target older individuals who are 30 years and above as they are more at risk of CRC, additionally they responded more positively to the graphics. Infographics designers should look into combining with other primary

sources of CRC information such as decision aids and clinicians to reinforce CRC knowledge among members of the public.

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1. Introduction

1.1 Background of Thesis

This project's literature review described infographics as a growing medium for health communication, although further research is required to confirm its effectiveness within the health industry. Infographics are defined as an image or diagram that displays information or data (Cambridge University Press, 2017). Infographics can appear in an animated or static form, and mixed reviews exist on which type is more effective in health communication (Witteman et al., 2014). This thesis compared animated and static infographic types to determine which is more beneficial within the context of Colorectal Cancer (CRC). The designed infographics portrayed both protective information and risk information about nutrition, and compared which is better remembered by respondents. This thesis also assessed which demographic groups responded more favourably to infographics by assessing age, education, ethnicity, and gender. Additionally, this project analysed whether infographics build on an individual's current knowledge of CRC and whether knowing someone personally with the condition will have a positive effect.

1.2 Rationale for Infographic Design and Research

CRC is the third most common cancer worldwide and the fourth most common cause of cancer death (World Cancer Research Fund, 2017). Australia and New Zealand have the highest age-standard incidence rates with 44.8 per 100,000 and 32.2 per 100,000 in men and women respectively (Schreuders et al., 2015). A growing concern with CRC is the increasing incidence developing worldwide with an expected 60% rise, which is more than 2.2 million new cases and 1.1 million deaths per year by 2030 (Arnold et al., 2017). A potential reason for this increase can be attributed to the lack of education of preventive measures such as healthy eating and physical exercise (McTiernan, 2008). A study recruited 2,419 CRC patients and 4,723 controls and identified reduced CRC risk when adhering to healthy eating (Odds Ratio 0.71, 95% Confidence Interval, 0.61-0.84) and physical activity (Odds Ratio 0.86, 95%

Confidence Interval, 0.75-1.00) guidelines (Turati et al., 2017). Furthermore, the lack of CRC screening from developed countries contributes to the increasing number of CRC cases and thus requires the development of screening education programmes (Schreuders et al., 2015). CRC knowledge contributes significantly to an individual's behaviour on cancer management. Individuals who are less knowledgeable on CRC are less likely to seek more information about the particular cancer. Additionally, low literate individuals would likely less engage with preventive factors such as screening (Von Wagner et al., 2009). A study that targeted Indigenous Australians and showed that by building their CRC knowledge through educational and promotional interventions, their participation of CRC screening increased (Christou & Thompson, 2012). Therefore, this project aimed to design infographics communicating dietary information to explain at a cellular level, how nutrition can increase or lower the risk of CRC to better inform people who are at risk. A partnership was formed with Bowel Cancer New Zealand for the infographics to be used on their social media and website.

Witteman et al. (2014) described the controversy behind the effectiveness of infographics in general health communication. Literature does little to explain different communication methods of preventive information in the context of CRC. Therefore, the purpose of this thesis was to compare animated and static infographics to convey nutritional information for CRC prevention and, to identify which design was better received by participants through measuring memory retention.

1.3 Thesis Creative and Academic Component

This thesis focused on five project questions:

1. Are animated or static infographics more effective in communicating dietary information for CRC prevention?

2. Is negative risk or protective information more effective in communicating dietary information for CRC prevention?

3. Which demographic groups (age, ethnicity, gender, education) responded more strongly to infographics?

4. Did infographics build on existing CRC knowledge for individuals who have previously heard of CRC?

5. Did infographics build on existing CRC knowledge for individuals who knew someone personally with CRC?

To address these questions, the creative component of this thesis used Adobe Illustrator Creative Cloud 2017 (ICC) to design four static infographics followed by the use of Apple's Keynote to animate those images to form a total of eight infographics. The academic component uses Qualtrics to design a multiple-choice survey to test viewers on how well they received the content presented on the infographics. A score out of nine based on the number of correct answers, was given to each participant, and average scores were compared between groups (e.g. animated compared to static groups). The surveys asked questions about each participant's demographic to determine which age/ethnic/education/gender groups responded more strongly towards infographics in general. Additionally, the survey asked questions of any previous knowledge of CRC and knowing anyone personally with CRC to determine whether infographics build on their existing knowledge of the disease. Amazon Mechanical Turk (mTurk) was used to recruit participants for this study through anonymous links.

2. Literature Review

This literature review discusses four communication areas. Firstly, health communication examines the uses of technology to communicate health information to individuals and addresses the need for health messages to be theory based. Secondly, cancer communication shows the need to build on patient literacy and understanding. The positives and negatives of electronic technology used for cancer information are then evaluated. Thirdly, dietary communication highlights the need to impact large populations to promote healthy eating behaviours. There are also different types of dietary interventions to target different population groups. Finally, infographics are discussed as media to communicate health information to various audiences.

2.1 Health Communication

Health communication continues to develop and evolve with technology. Mobile phones, telecommunications, and the Internet have displayed their usefulness by reaching large populations, building on clinician and patient relationships, and bridging communities. These technologies have proven to be cost-effective and accessible, with the potential to impact health behaviours positively. The use of technological communication methods enables patients to participate in their own healthcare management. However, this review finds that health communication interventions should aim to be theory-based to provide valid health information most effectively to the in public.

2.1.1 Theory-Based Health Messages

Implementing and targeting behavioural theory within individuals in response to health messages strengthens the attentiveness to health messages (Webb et al., 2010). The theory of planned behaviour explores an individual's willingness to act based on personal beliefs. Another example is the self-determination theory, which looks into factors that affect personal motivation (Hagger & Chatzisarantis, 2009). Theory is defined as a set of explanations or ideas to describe a fact or event (Cambridge University Press, 2017). When publicised or presented to the public, health

interventions that include strong scientific evidence tend to have more reliable results compared with responses that do not (Jetha et al., 2011; Webb et al., 2010; Tristani et al., 2017).

The theory of planned behaviour originates from the work of Icek Ajzen and describes human social behaviour is based on a set of organised actions that are of natural routine in response to an event or moment (Ajzen, 1985). The theory is founded on three principles, one's attitude towards a behaviour (the favourability or unfavorability to complete the behaviour in question), the subjective norms (the perceived social pressures to execute or not execute the particular behaviour), and the perceived behavioural control (an individual's perceived difficulty or ease to implement the behaviour) (Ajzen, 1991). In relation to the designed infographics for this thesis, incorporating the theory of planned behaviour provides an opportunity for viewers to undergo a natural lifestyle of healthy eating for CRC prevention. Furthermore, the theory relays that an individual's level of the three principles would differ between individuals, which may influence a person's willingness to retain information from the infographics.

Health communication interventions with supporting theory have a greater impact in promoting healthy behaviour change within communities. Webb et al. (2010) reviewed 85 interventional studies and showed those which incorporated the theory of planned behaviour were more likely to significantly affect healthy habits (Webb et al., 2010). Additionally, interventions that included behavioural change techniques showed larger effects compared with responses that did not.

Messages on websites are commonly general-knowledge based and lack supporting theory and practice (Tristani et al., 2017). Tristani et al. (2017) conducted a study through Google evaluating a series of websites, which relate to physical activity. Their findings suggest that the information presented on websites was commonly known. Parents who have children or youth with disabilities use the Internet as a source of information and are well aware of the health benefits and limitations of physical activity.

Behavioural theory can be incorporated into health messages to support patients with spinal cord injuries (Jetha et al., 2011). Jetha et al. (2011) examined 30 websites that provided physical activity information. Twenty-three of the 30 sites (77%) had little theoretical quality, causing them to score below 9 out of 14 possible points for academic content. Moreover, only 6 out of the 30 websites (20%) supplied physical activity advice, and within those websites, the information lacked validity.

Theory based messages provide a foundation for health messages to be informative, validated and accurate (Jetha et al., 2011; Tristani et al., 2017). Webb et al. (2010) reviewed 85 studies and concluded that studies which included the theory of planned behaviour positively affected health habits (Webb et al., 2010). Tristani et al. (2017) assessed physical activity information presented on websites and identified it was significantly general knowledge based, which lacked supporting theory. Also, Jetha et al. (2011) identified that the majority of physical activity websites demonstrated poor theoretical quality.

2.1.2 Mobile Phone Interventions

Mobile technology can connect patients over long distances (Tuot & Boulware, 2017). Ninety-two percent of young adults in the United States (US) own a mobile phone (Poushter, 2016). The prevalence of mobile phones means they have the potential to impact multiple health areas by communicating risk factors, influencing patient behaviour, and developing relationships between clinician and patient (Khan et al., 2016; Prokhorov et al., 2017; Sharifi et al., 2013). Cell phones could integrate with the Internet and develop smartphone applications for stronger health management and treatment adherence (Albini et al., 2016; Buller et al., 2014; Carter et al., 2013; Landy et al., 2012).

Mobile phones have displayed the ability to communicate with long-distance patients. For example, a program called "Telehealth" was reviewed to see its effectiveness in supporting long-distance health care, clinician and patient education, and public health administration (Tuot & Boulware, 2017). Telehealth incorporates electronic and telecommunications technology, to aid patients with chronic kidney disease (CKD) and assist public health members involved with CKD patient management.

Tuot & Boulware (2017) concluded Telehealth had the ability to improve CKD education and encourage behavioural change for both health providers and patients.

Mobile phones also have text messaging as a medium to communicate health risk factors. Text messaging has been shown to impact different areas of health like asthma (Strandbygaard et al., 2010), heart failure (Nundy et al., 2013), prenatal care (Evans et al., 2012) and adherence to medication (Foreman et al., 2012).

A text-messaging program was developed to inform college students about the risks of traditional and modern tobacco products (Prokhorov et al., 2017). Thirty-one tobacco users and non-users, aged 18 to 25 were involved in five focus groups, to discuss the effectiveness of text messages. Students contributed feedback on message content and structure. Prokhorov et al. (2017) reported the text messages were compelling and suitable for the students and further discovered the students previously lacked knowledge about the risk factors involved with tobacco products.

Text messaging can influence health behaviours related to specific conditions such as obesity. A study was conducted with focus groups and interviews with parents of overweight and obese children, to examine their views on text messaging (Sharifi et al., 2013). The aim of the study was to support healthy behaviours within obese children. A total of 31 parents responded positively about text messaging and preferred it to written or email communication. The text messages provided were short and regularly notified the parent. Sharifi et al. (2013) suggested improvements by personalising the information towards specific patients, and supplying additional information by providing links to websites. Sharifi et al. (2013) showed that text messaging could be a potential method to support obese children and their associated health behaviours.

Mobile phones and the Internet can be combined to manage patient health. A pilot study examined the combined technology of cell phones and Internet to improve hypertension management (Albini et al., 2016). The study recruited 690 hypertensive patients recruited and divided them into a control group with repeated office visits and an intervention group with electronic communication (mobile phone and the Internet) tools to monitor blood pressure. Albini et al. (2016) showed patients who used

electronic communication tools had better adherence to treatment protocols and greater involvement in their hypertension management. Furthermore, relationships between clinicians and patients increased as electronic communication caused patients to become more involved in their healthcare and clinicians to be more attentive in the monitoring of blood pressure levels.

Inflammatory bowel disease (IBD) management can also operate through mobile phone and Internet technology. IBD patients underwent surveys in regard to their access to technology and its effectiveness in IBD management (Landy et al., 2012). Fifty-two IBD patients responded with 56% of those patients owning a smartphone. Fifty-two percent of patients used smartphone applications consistently, 65% of the patients who responded preferred text messaging for reminders on IBD management and another 65% of the patients who responded preferred telephone follow-ups. Comparing this to Internet use, 94% of patients had Internet access at home, 46% of patients regularly used online video calling, and 54% of patients preferred electronic mail for reminders on IBD management. Additionally, 38% preferred online follow-ups and 42% of patients suggested the use of an online self-management system for IBD. This study has shown IBD communication can come through a different medium to reach large populations of IBD patients.

A separate qualitative study of 15 IBD patients was conducted in focus groups, to identify struggles that patients faced living with IBD (Khan et al., 2016). Khan et al. (2016) determined that a lack of communication existed between the clinician and patient. Khan et al. (2016) proposed the need for a mobile application to monitor symptoms and treatment adherence, thus inviting further accountability between clinician and patient.

Smartphone applications are another mobile intervention growing in development for general health communication. Evidence has shown individuals who are engaged in weight loss show better retention and adherence to smartphone applications compared to website applications and standard paper diaries (Carter et al., 2013). In addition, smartphones have also shown the ability to aid cigarette smokers into quitting (Buller et al., 2014). Although, Buller et al. (2014) mentioned time was required for users to familiarise themselves with the interface before it becomes regular standard practice.

Cell phones have the ability to reach long distance patients shown through the Telehealth program (Tuot & Boulware, 2017) and target multiple types of health outcomes. Prokhorov et al. (2017) described the use of text messaging to communicate risk factors involved with tobacco products (Prokhorov et al., 2017). Additionally, text messaging can be used to influence positive health behaviours in children who are obese (Sharifi et al., 2013). Mobile phones have the ability to merge with Internet technology for hypertension management and displayed increased adherence to treatment protocols (Albini et al., 2016). IBD patients have also adopted the use of mobile phone and Internet technology and further suggested the design of mobile phone applications to develop clinician and patient relationships (Khan et al., 2016; Landy et al., 2012). Smartphone applications are also a growing mobile intervention shown to be used in both weight loss and smoking cessation (Buller et al., 2014; Carter et al., 2013).

2.1.3 Internet-Based Interventions

The Internet can bring health communities together and promote self-management of disease (Frost and Massagli, 2008). Internet usage is commonly cost-effective, accessible to the public, and can reach patients over considerable distances (Boyd et al., 2013). Multiple types of websites exist for health education. However, it is difficult to determine the independent effects of the Internet on health behaviours as it is regularly integrated with other technologies (Lau et al., 2011; M. Piovesana et al., 2016; Taveira-Gomes et al., 2016).

A systematic review evaluated nine interventional studies, which use mobile phones and the Internet to promote physical activity in children (Lau et al., 2011). Electronic databases (Medline, PsycInfo, CINAHL, and Web of Science) were used to retrieve studies published from 1st January 1997 to 31st December 2009. The gathered studies explored the uses of the Internet, email and text messaging to encourage physical activity in children (6 – 12 years old) and adolescents (13 – 18 years old). Lau et al. (2011) concluded difficulties in determining the effectiveness of mobile and Internet technology independently; due to both technologies integrated with other communication mediums, such as face-to-face interactions.

Another systematic review assessed 251 studies that used the Internet for health education (Taveira-Gomes et al., 2016). Taveira-Gomes et al. (2016) discovered 46% of the studies used websites that included text and images, whereas 22% of the studies used sites with text alone, and 7% of the studies used interactive websites and multimedia. Seventy-five percent of the studies reviewed had references in common. Overall, the review lacked comparative evidence to show which types of sites were more useful. Taveira-Gomes et al. (2016) exhibited that almost half of websites combine the use of text and images but are limited in the use of interactive material.

The Internet enables the formation of patient communities to encourage self-management of their health. "PatientsLikeMe" (PLM) is an online community designed for communication between amyotrophic lateral sclerosis (ALS) patients (Frost and Massagli, 2008). Frost and Massagli (2008) assessed the effectiveness of PLM and the willingness of ALS patients to discuss their health data on PLM. PLM used graphical data to illustrate treatments, symptoms, and ALS patient outcomes on personal profiles. Forums, private messaging, and comments were examined to assess patient communication. Frost and Massagli (2008) revealed that patients who chose to share their health data and engaged in conversation with other patients displayed the potential for disease self-management.

Internet programs are another medium for health communication. “Move it to improve it” (Mitii) is an online program that implements a series of activities and virtual trainers, to build motor control and cognitive thinking (Boyd et al., 2013; M. Piovesana et al., 2016). Piovesana et al. (2016) targeted children with cerebral palsy (CP) and examined whether Mitii improved their executive function (EF). EF collectively measured attentional control, information processing, cognitive flexibility, and goal setting. Overall, Mitii did not display a statistically significant increase of EF with CP children.

In conclusion, systematic reviews described mobile phone and Internet technologies could be used to encourage physical activity in children. However, there are challenges in identifying the effectiveness of mobile phone and Internet technologies independently, as it is commonly integrated with other communication methods (Lau et al., 2011). Taveira-Gomes et al. (2016) showed online information often merges the

use of images and text but is restricted in the use of interactive features. The Internet provides the ability to form online communities like PLM where Frost and Massagli (2008) examined its effectiveness in motivating ALS patients and found that patients who shared their health data were more driven to self-management of the disease. However, Internet programmes like Mitii may not be an effective tool for children with CP. Piovesana et al. (2016) observed no change in EF within CP patients through the implementation of Mitii (Boyd et al., 2013).

In summary of this section, health communication technologies have developed in the shape of mobile phones, telecommunications and the Internet. The techniques shown have the ability to reach out to large audiences, be highly accessible and bring communities together. A growing area in health communication is for patients to take control of their healthcare by creating a space for patients to make treatment decisions. Additionally, it is important to identify areas of health knowledge that patients may be lacking. In the design of public health messages, having messages that are supported by theory is a significant factor for producing a greater effect and ensuring messages are sound and valid.

2.2 Cancer Communication

As patients and member of the public build on their understanding of cancer, it enables independence in their healthcare and encourages decision making in regards to treatment. Although the Internet is cost-effective, accessible and has the potential to bring communities together, it has gained mixed responses on its favourability as a reliable source of information. In contrast, the design of smartphone applications has shown to aid treatment adherence for cancer patients.

2.2.1 Patient Numeracy and Decision Making

Having strong numeracy skills is important for cancer patients to make informed decisions about treatments, screenings, and prevention. Cancer patients commonly compare risk statistics about treatments to make appropriate choices about their healthcare (Fagerlin et al., 2011). A potential consequence of low numeracy skills is the lack of treatment compliance and the subsequent reduced availability of

treatments (Nelson et al., 2008). To avoid such consequences, methods such as the use of visualisations (Garcia-Retamero & Galesic, 2010), and decision aids (Trikalinos et al., 2014), as well as displaying absolute risk data may support cancer patients with low numeracy to make educated choices about their health care.

Patients who have low numeracy skills require additional assistance to understand cancer data. A review described cancer patients who have low numeracy required further explanations about cancer risks to engage in healthy behaviours (Nelson et al., 2008). Nelson et al. (2008) further showed that patients with low numeracy skills are less informed about cancer information, and therefore limited in treatment decisions. Furthermore, they show signs of reduced medication compliance, and are disadvantaged in risk communication.

Decision aids are potential tools to support cancer patients with their decision making of treatments and screenings. A review analysed evidence in regards to the effectiveness of decision aids for cancer patients who require assistance in cancer screening and treatment decisions (Trikalinos et al., 2014). Eighty-seven articles were applicable due to the exclusion criteria. Trikalinos et al. (2014) identified that individuals who used decision aids showed better knowledge scores compared with people who did not use decision aids. Trikalinos et al. (2014) observed lower conflicts when decision aids were applied, and greater awareness of treatment/screening risks within patients. Trikalinos et al. (2014) deduced that decision aids can increase a patient's knowledge about cancer treatments and screening and allowed them to make decisions that align with their values.

Patients who have low numeracy skills tend to take statistical data out of context. Garcia-Retamero & Galesic (2009) administered a survey to evaluate participants and their responses to differing treatment scenarios. Some scenarios consisted of equal numbers of treated and non-treated patients while others displayed higher numbers of treated patients, or vice versa with non-treated patients. Collectively, participants focused more on the number of treated and non-treated patients who died, without considering overall patient numbers (Garcia-Retamero & Galesic, 2009). Conversely, participants who received icon arrays started to incorporate total patient numbers when evaluating scenarios.

Specific applications can be used to support cancer patients with their treatment decisions and cancer literacy. Fagerlin et al. (2011) suggested health-care providers and educators should aim to use primary language terms, pictographs, and absolute risks for effective numerical communication towards cancer patients (Fagerlin et al., 2011). Specifically, absolute risks should be displayed in a percentage form to show the change in risk by specific treatments.

In conclusion, Nelson et al. (2008) commented that patients who have low numeracy skills require more support in understanding cancer risks (Nelson et al., 2008). By improving patient numeracy, it would aim to encourage patients to make well-informed decisions about treatment, screening, and prevention (Fagerlin et al., 2011). Fagerlin et al. (2011) propose the use of pictographs, simple language terms, and the display of absolute risks in a percentage format, to efficiently communicate numerical data. Decision aids are a promising method to improve a patient's knowledge, but it is unclear whether it is directly causing patients to make informed decisions. Patients may require visual tools such as icon arrays to evaluate cancer data without bias to make educated decisions on health care (Garcia-Retamero & Galesic, 2009).

2.2.2 Electronic Communication in Cancer (The Internet and Mobile Phones)

Mixed responses exist with Internet use to communicate cancer information. Internet use for cancer information has been viewed as challenging and intimidating by some, while others reported it to be favourable in building stronger clinician-patient relationships (Lee et al., 2010; Littlechild & Barr, 2013). Furthermore, Internet use has been growing rapidly in English speaking countries (Foroughi et al., 2016). Understanding the Internet is important because it is a cost-effective and accessible resource for cancer information, and it has the potential to educate patients about cancer information and build public health communities (Maddock et al., 2011). Online technology assists patients in their therapy and clinicians are frequently adopting the use of online technology along with tablets and smartphones for health purposes (Drews et al., 2016; Kirkovits et al., 2016). Social media is a growing hub for cancer information, however, the Internet is lacking preventive information on cancer (Ginossar, 2016; Ruckenstuhl et al., 2016). Additionally, the design of

smartphone applications for treatment adherence is growing in popularity for patients (Fishbein et al., 2017).

Breast cancer patients seeking cancer information online have found it problematic and challenging. A ten-item questionnaire was used to survey breast cancer patients from the University Hospital of South Manchester, between May and June 2011 (Littlechild & Barr, 2013). Of the 200 completed surveys, 50.5% of patients were using the Internet to seek breast cancer information. Younger patients with high household incomes were more likely to use the Internet. While 73% of patients found the Internet helpful, 30% found it challenging. Out of those patients who encountered difficulties, non-European patients (64%) were more challenged compared to Europeans (25%).

In addition, miscommunication of cancer information from the Internet could potentially lead to poor decision making and decreased motivation to undergo cancer treatments (Gilstad et al., 2017). Internet use also has other consequences such as the decreased engagement between patients and clinicians to receive health advice. The decline on expert authority may also lower the quality of health management as patient and clinician relationships could lessen (Donnelly et al., 2008). Therefore, the content of the infographics was sourced from trusted experts from the World Cancer Research Fund.

Patients in English speaking countries commonly use the Internet to search cancer information. Google Trends was used to evaluate countries and their research activity on Google, from January 2004 to December 2015 (Foroughi et al., 2016). Foroughi et al. (2016) assessed five countries in which English is a prominent, or primary language the US, Canada, Australia, New Zealand (NZ), and United Kingdom (UK). The US, Canada and Australia were the highest countries searching cancer followed by NZ and UK respectively. Within their respective countries Baltimore (US), St John's (Canada), Sydney (Australia), Otaika (NZ) and Saint Albans (UK) were the highest town/cities for cancer searching. Commonly breast cancer was searched for in all countries, with pancreatic (Canada) and ovarian cancer (NZ) growing in search activity.

Active participation of patients in their medical treatment encourages self-management of their health care. Lee at al. (2010) implemented a study to observe whether Internet use in cancer patients would lead to greater patient involvement (Lee et al., 2010). Breast, prostate, and colon cancer patients underwent surveys to evaluate their decision-making activity after Internet use. Lee et al. (2010) randomly selected 2013 participants from the Pennsylvania Cancer Registry. The results showed that patients who used the Internet responded with higher decision-making activity. Lee et al. (2010) concluded that high Internet use might lead to increased self-management.

Internet and telecommunications have displayed the ability to carry therapy assistance for breast cancer patients. Breast cancer patients filled out 169 questionnaires and provided responses about new electronic communication tools. The results showed 95.8% of breast cancer patients used the Internet, with 91.5% utilising it for health purposes. Also, 63.7% requested the Internet as a medium for therapy assistance, whereas 25% and 73.2% requested mobile phones and a call centre respectively. Breast cancer patients who were diagnosed less than five years before the survey (implemented in 2012) were more likely to prefer call centre use compared to patients diagnosed greater than five years (Drews et al., 2016).

Clinicians are also utilising online resources for breast cancer care. A survey of 120 clinicians showed 99.2% were using the Internet for general purposes and 98.3% using it for medical applications (Kirkovits et al., 2016). Kirkovits et al. (2016) further found 99.2% of clinicians owned a computer, 31.9% possessed a tablet, and 73.1% owned a smartphone. The Internet as a useful information source to support breast cancer patients was agreed by 66.4% of clinicians. Overall, Kirkovits et al. (2016) displayed not only are patients seeking information through the Internet but also clinicians as well.

An ongoing online hub comprising of cancer specialists is a potential place for cancer patients to expand their knowledge and contribute to discussions. Maddock et al. (2011) created a survey to gain feedback from cancer patients about seeking cancer information online, particularly through the use of social media. Respondents of the survey desired accessible and accurate information about cancer and how it was going to affect them personally. Questionnaires were distributed from patient organisations

and through partners from the Eurocancercoms project. Maddock et al. (2011) suggested the design of an online community called “ecancerHub” as a resource for cancer information. The outcomes of ecancerHub would aim to produce cancer information that is reliable, comprehensible, and easy to locate for patients.

A Facebook group called "Ewing Sarcoma Awareness" (ESA) that targeted Ewing Sarcoma (ES) patients aimed to share information between patients and families (Ruckenstuhl et al., 2016). ESA had 65 members and the survey evaluated Facebook posts, likes, threads, and links for six months. From the study, 70% of members responded that they used ESA as a hub for ES information, and 89% of participants agreed being around other patients who have ES made it easier to cope with the condition. Also, 20% acknowledged ESA as an influence on their treatment decision and 15% commented ESA changed their choice of specialist. ESA has shown the ability to lead patients with their treatment decisions. Furthermore, ESA was displayed as a site for constant mental and emotional support.

A struggling area of online cancer information is the lack of resources on cancer prevention. A survey was conducted to examine the social determinants and behavioural factors of Internet seeking on Cancer Prevention Information (CPI) (Ginossar, 2016). The survey received 252 responders and identified 44.4% of respondents would use the Internet to seek CPI. For each year increase in age, 3% of participants would be less likely to use the Internet for CPI. Individuals who did not complete high school were 11.75 times less likely to mention the Internet as a CPI source, whereas respondents who completed high school were three times less likely compared to college graduates. Ginossar (2016) concluded social determinants have an influence on seeking CPI through the Internet. The study suggested for clinicians and health policymakers to focus on a patient's cancer prevention by increasing access to theory based CPI.

Designing smartphone applications may increase adherence towards oral chemotherapy treatment. Fishbein et al. (2017) received feedback from patients, family members, oncology clinicians, health care representatives, and practice administrators to design a smartphone application. Smartphone application features included reminders for taking medication, patient responses to symptoms and

adherence to medicines, Fitbit fitness technology, nutritional information, and social networking resources. A randomised control trial is currently being organised to assess the effectiveness of the smartphone application for adherence to oral chemotherapy.

In the context of this study, mobile devices and the Internet enables greater accessibility to the infographic designs for at risk individuals. The infographics and animations designed for this project do not contain large amounts of text and coveys a simplistic message towards audiences which was recommended by the Littlechild & Barr (2013) paper. In addition, the Internet focuses heavily on cancer treatment and therefore, the infographics aimed to communicate preventive information in the context of nutrition.

Overall, Littlechild & Barr (2013) have described Internet use as problematic and challenging for breast cancer patients. However, Foroughi et al. (2016) have shown the increasing popularity of cancer searching through Google in English speaking countries. The Internet can aid patients in their decision making of cancer treatments, specifically when therapy assistance for breast cancer patients comes from combined Internet and mobile technology (Drews et al., 2016; Lee et al., 2010). Clinicians are adopting the use of the Internet, tablets and cell phones for medical purposes (Kirkovits et al., 2016). Facebook groups such as ESA have been shown to provide support for ES patients and treatment advice (Ruckenstuhl et al., 2016). However, the Internet lacks CPI and requires further development (Ginossar, 2016). On the other hand, mobile phone technology has shown popularity through smartphone applications with the inclusion of preventive health features such as nutritional information (Fishbein et al., 2017).

In summary of this section, patients with low numeracy show a lack of understanding when making informed decisions about cancer treatment. Interventions were described as helping develop cancer numeracy such as the application of pictographs, decision aids, and the display of risk information in an absolute risk format. A focused method of communication is the use of Internet systems. However, the use of online resources is controversial. A successful online tool is the use of online chat rooms to share cancer information with peers and receive psychological support. This

section has also touched on the combined strength of both Internet and Mobile technology when used jointly. Clinicians are beginning to adopt the uses of modern technology and are contributing through online hubs to support and supply cancer information to patients.

2.3 Dietary Communication

Dietary messages have the potential to influence large population groups. It is important they are designed well to gain understanding and have the influence to impact policies and the food marketplace. Dietary interventions come in different forms to communicate dietary information, with the aim of changing healthy-eating behaviours positively. With the vast diversity of diet interventions, there is the capacity to reach a variety of social and ethnic groups.

2.3.1 Dietary Messages: Design Considerations

Developing nutritional messages is important in promoting healthy eating behaviours. However, when creating nutritional messages, it is important for the message to be practical and understandable. For information to hold authority in the public setting the ability to target large populations are necessary (Fitzgibbon et al., 2007; Wakefield et al., 2010). Messages need to be well resourced and funded to have the potential to influence people's behaviour who are at risk of CRC (Fitzgibbon et al., 2007; Hornik & Kelly, 2007). Moreover, considering social determinants is important in the message design. Messages have to be efficient and understandable, and therefore, careful selection of dietary terms is necessary for different target audiences (Pettigrew et al., 2017).

Mass media campaigns have the ability to encourage positive health behaviours in populations. Mass media involve the use of television, radio, and newspapers (Wakefield et al., 2010) that can cover large populations to promote healthy dietary behaviours. Nutritional messages or campaigns need to be well resourced and funded to impact a public setting (Hornik & Kelly, 2007; Wakefield et al., 2010). Furthermore, social determinants such as social class, social networks, ethnicity, and

surrounding neighbourhoods can influence the favourability of dietary health campaigns (Viswanath & Bond, 2007).

A two-day workshop was organised by the National Cancer Institute (NCI) and the Division of Nutrition Research Coordination (DNRC) (Fitzgibbon et al., 2007). The workshop included communication, nutrition, and behavioural scientists, market researchers, media advocates, journalists, and public policy experts. The workshop aimed to identify the most optimal ways to communicate dietary messages. The review suggested targeting nutritional messages towards large populations as opposed to individuals. At an individual level, personal knowledge, families, schools, neighbourhoods, social and cultural factors can influence dietary decisions. Behavioural and communication theory should support nutritional messages. Moreover, communication of messages should aim to be practical and motivating to impact policy and the food marketplace.

Appropriate selection of dietary terms is important to maximise the understanding of nutritional messages communicated to audiences. A study observed Australian adults and their perceptions of four terms to define non-healthy foods, "junk food, snack food, party food, and discretionary food" (Pettigrew et al., 2017). The online survey received responses by 409 Australian adults aged 25 to 64. Pettigrew et al (2017). showed "junk food" was more related to unhealthy eating, whereas "snack food" was associated with both healthy and unhealthy eating. "Discretionary food" was the term participants related with less. Overall, different audiences have different terms to describe unhealthy foods, and therefore, careful selections of words are essential for comprehension of diet messages.

Mass media can be a potential method to communicate dietary messages. However, interventions need to be well resourced and funded to impact diverse communities (Hornik & Kelly, 2007; Wakefield et al., 2010). Ethnicity, social networks, and surrounding neighbourhoods influence how dietary messages are taken in (Viswanath & Bond, 2007). Fitzgibbon et al. (2007) described the need for nutritional messages to be theory based and have the strength to change policy and influence individuals at risk of CRC. For dietary messages to be understood, selecting terms that audiences

can comprehend is important for readers, as they tend to have personalised meanings of certain nutritional terms (Pettigrew et al., 2017).

2.3.2 Dietary Interventions

Dietary interventions are significant in persuading individuals that healthy eating can contribute to cancer prevention and non-communicable diseases (Muller et al., 2016; Sullivan & Klassen, 2007). There is a lack of dietary information supplied towards cancer patients, and implementing these interventions would educate audiences about nutritional information. The aim of dietary interventions is to encourage healthy eating behaviours (Pullar et al., 2012). Dietary information can come from various media such as nutritional programmes and mobile and Internet technology (Muller et al., 2016; Sullivan & Klassen, 2007). These interventions can reach out to target audiences such as low to medium income countries (LMICs) to promote healthy eating behaviours (Mayén et al., 2016).

Dietary interventions have the ability to improve healthy eating in low-middle income countries (LMICs). A systematic review analysed seven interventional studies implemented in seven LMICs. The majority of interventions used printed material, media, and face-to-face interactions to introduce nutrition education. Three out of the four interventions were aimed at disadvantaged populations and displayed improved healthy eating behaviours, indicating that dietary interventions have the potential to lessen social inequalities (Mayén et al., 2016). In the context of a NZ population, at risk ethnic groups such as Maori and low income earning individuals can potentially engage with dietary interventions to reduce cancer inequalities (Soeberg et al., 2015).

The use of electronic and mobile health (e & mHealth) as interventions has been described to promote healthy diets in developing countries. A systematic review evaluated 15 studies and found the Internet and text messaging were standard methods to supply physical activity and dietary information. Most of the studies showed e & mHealth interventions were encouraging physical activity and healthy diets. Specifically, 70% of the interventions promoted healthy diets (Muller et al., 2016).

Patients having sufficient dietary information are important to influence healthy eating behaviours. A NZ study recruited 40 colorectal cancer (CRC) patients, where 61% of patients received inadequate information about diet. Additional dietary information was requested by 98% of patients and 75% of patients claimed to have changed their diet in response to receiving nutritional information. Patients described their doctor or nurses as having provided information. In response to this study, a learning package was created for these patients (Pullar et al., 2012). Furthermore, another NZ study also indicated that there was a lack of dietary information given to CRC patients. Of the 30 CRC 50% patients mentioned that no nutritional information was given after their surgery (Cha et al., 2012).

Nutritional programmes can influence positive cancer prevention attitudes. Between 2001 and 2002 a nutritional educational programme in Washington D.C. involved 157 African American women. Participants provided responses on the importance of nutrition in cancer prevention through questionnaires before and after the programme. Women in the study responded saying the project aided them and agreed that healthy foods could prevent cancer (Sullivan & Klassen, 2007).

Overall, there is a lack of dietary information provided for cancer patients, specifically in NZ (Cha et al., 2012; Pullar et al., 2012). Introducing interventions such as nutritional programmes, mobile phones, and the Internet have the potential to better inform patients about healthy eating behaviours (Muller et al., 2016; Sullivan & Klassen, 2007). Furthermore, interventions can also target audiences such as LMICs and therefore, show the ability to cover diverse populations (Mayén et al., 2016).

In summary of this section, for dietary messages to be useful in a public setting, large population groups need to be targeted. A lack of nutritional information exists for cancer patients to make appropriate decisions about treatment. Multiple diet interventions have the ability to cover diverse social and ethnic groups. Effective interventions have the potential to affect eating behaviours of patients and prove that healthy food plays a role in cancer prevention and other non-communicable diseases.

2.4 Infographics and Health Communication

Infographics are a developing medium in healthcare to inform individuals about positive health behaviours, risks, and data. They have the potential to enable patients to make positive decisions about their treatment and build on clinician and patient relationships (Arcia et al., 2016; McCrorie et al., 2016). When designing infographics, taking into account different audiences and health literacy are important to optimise health understanding in patients (Crick & Hartling, 2015; Gaissmaier et al., 2012; Garcia-Retamero & Galesic, 2010; O'day, 2007). Infographics can be designed through collaborations such as design and science disciplines to increase time efficiency and productivity (Bellei et al., 2016). As social media grows in popularity among communities, it is becoming a desirable place to display infographics (Duggan, 2013).

In the formation of infographics, collaborations have been favourably viewed by scientists. Cooperation among different academic disciplines would lead to better use of time and access to a diverse set of skills. A review displayed an example of collaboration through Immunology and design disciplines (Bellei et al., 2016). The James Cook University, Australia, organised a project, which led to the development of a series of three-minute videos, describing the immune response towards an infection. The videos presented were in an animated infographic format, which targeted entry-level tertiary students. The review concluded the infographics were unique, innovative and cost-effective. Furthermore, it exemplified collaboration between the arts and sciences.

Specific infographic features are more favourable than others. Participants of a study were invited into design sessions to evaluate infographics and provide feedback towards different design types (Arcia et al., 2016). Arcia et al. (2016) identified that the infographics were generous with information, provided context, standard colour, and symbolic analogies. However, participants reported they did not favour the use of repeated icons to symbolise multiplication on the infographics. Arcia et al. (2016) concluded that infographics should be carefully designed to enable the viewer to connect and comprehend the communicated information.

Social media is a desirable place to share images with individuals. The Pew Research Centre conducted a national survey of 1000 U.S adults to evaluate the posting of images on the Internet (Duggan, 2013). The study involved participants who were 18 years and over, and was conducted between the 3rd and 6th of October 2016. The Pew Research Center reported 852 participants were Internet users whereas 941 were cell phone users. Of the adult Internet users 54% post images and videos that have been created by them, which is an increase from 46% in 2012. Additionally, 47% of adult Internet users repost images and videos found online on other image sharing websites, which is an increase from 41% in 2012. Collectively 62% of adult users have done either one of these activities, which is a significant increase from 52% in 2012.

Infographics can aid in the understanding of study results to clinicians and be a possible tool for health education in patients. In the US 397 disability risk factors were identified in post-stroke individuals. Risk factors were illustrated in an infographic format to show the varying levels of importance for each risk factor and their relationship with disability. Yoon & Gutierrez (2016) described infographics as a probable medium for health communication.

Infographics can come in different forms such as animated or static. A study compared the efficacy between animations or static graphics for long-term memory retention (O'day, 2007). In the study 393 participants evaluated three animations and two graphics (with and without a legend). O'day (2007) found after 21 days of viewing; the students retained more information from the animation (without narration) compared to the graphics regardless of figure legend. O'day (2007) concluded there is value in animations but require further research and development is required.

Specific audiences have their own preferences in the presentation of health data. An organisation called TREKK (Translating Emergency Knowledge for Kids) compared two different types of mediums to communicate health data (infographics and critical appraisals) (Crick & Hartling, 2015). Researchers, clinicians, health consumers and health organisations make up TREKK. TREKK aims to expand health knowledge to develop emergency care for children. The study showed 24 out of 47 (51%) members preferred the infographic compared to the critical appraisal. Specifically, 15 out of 22

clinicians (68%) preferred the critical appraisal while 8 out of 12 nurses (67%) preferred the infographic. The critical appraisal showed clarity whereas the infographics showed high artistic appeal. Participants suggested infographics would be better suited for patients and caregivers whereas critical appraisals would be more tailored to health professionals.

Low graphic literate audiences do not prefer the use of data visualisations because it is challenging to comprehend. Gaissmaier et al. (2012) proposed having statistical understanding is important to make appropriate medical decisions (Gaissmaier et al., 2012). Gaissmaier et al. (2012) conducted a study to compare graphical and numerical representations of health data. In the study, 275 individuals were randomly sorted to receive either an image with high graphical elements (icon arrays and photographs) or little graphical elements (numbers). Gaissmaier et al. measured participants in their understanding, recall, and aesthetic appeal responses. Primarily measurements in understanding and recall of data showed the most difference between groups. High graphic literate individuals had better recall and understanding when the presentation of health contained significant amounts of graphical elements. Alternatively, non-visual people preferred data presented in a small-scale graphical format for greater recall and understanding. Therefore, selecting appropriate audiences for data visualisation is important to maximise comprehension with the target audience. In the context of this study, the target population are individuals who are at risk of CRC.

Incorporating explanatory features into graphical forms of health data can increase understanding within low graphic literate individuals. Okan et al. (2015) believe icon arrays are a useful method to communicate health risk information. However, they are not effective among non-visual literate people. Okan et al. (2015) proposed the inclusion of explanatory labels, reflective questions and response feedback to develop a healthy understanding for individuals who do not tailor to visual displays (Okan et al., 2015). The features were randomly presented sequentially on the icon array. Okan et al. (2015) concluded the labels significantly supported low graphic individuals in their understanding and that the reflective questions increased knowledge in both low and high graphical groups.

The use of visualisations can be used to improve health numeracy. A study looked into the effectiveness of different types of displays such as icon arrays and bar graphs, which incorporated statistical information in the form of relative risk or absolute risk. Numerical and graphical skills were also evaluated to see the effectiveness of visualisations on participants (Garcia-Retamero & Galesic, 2010). Garcia-Retamero & Galesic (2010) concluded there was an increase of statistical understanding when icon arrays and bar graphs were used. Specifically, the displays supported participants who had low numeracy skills but high graphical literacy skills.

In the context of this project, the infographics designed aimed for viewers to build on their numeracy and literacy of nutritional information. The objective of the infographics was to inform viewers about preventive eating strategies and the risks involved in consuming specific food groups. In being more aware of nutritional risk and protection, viewers would be more engaged in health management and be more involved with their healthcare providers.

In conclusion, collaborations are an essential component to produce infographics that are cost effective, innovative and time efficient (Bellei et al., 2016). Yoon & Gutierrez (2016) showed that health risk factors communicated through infographics to post-stroke individuals are possible. With social media being a dominant area for image sharing (Duggan, 2013), infographics provide an avenue for patients to develop their medical education, which would lead to better self-management of health care and improved clinician relationships (Arcia et al., 2016). Although infographics come in different designs, O'Day (2007) showed animated infographics were more efficient in communicating health information towards students. Different audiences have particular preferences in data presentation. Crick & Hartling (2015) suggested infographics is suited more towards patients and caregivers whereas critical appraisals would be more tailored for health professionals. Furthermore, Gaissmaier et al. (2012) described low-graphic individuals did not prefer the use of data visuals. However, Okan et al. (2015) described the incorporation of explanatory labels and reflective questions to better support low-graphic individuals. Not only can graphics support non-visual individuals but also help people with low numeracy skills. To share infographics, social media and the Internet is a potential site for dissemination (Garcia-Retamero & Galesic, 2010).

2.5 Conclusion of Literature Review

In conclusion, this review found that there is a lack of health numeracy and literacy for cancer patients, which hinders effective communication and understanding. Infographics provide an opportunity to disseminate health information, but evaluation of target audiences is required. The literature review discussed a few studies that involved children. In the context of this project, the study population is on adults and therefore would expect a greater knowledge of CRC. Furthermore, adults are more independent in their lifestyles and may require trusted accountability to engage in preventive measures for CRC. The chapter suggests text messaging and online interventions as a cost-efficient system to build treatment adherence, reach large population groups, and target long distance patients. In the context of cancer, the use of Internet technology is controversial and requires further studies to cement its validity. However, online social media is a favoured medium to share and upload images. When considering infographics, incorporating theory-based messages can be useful to encourage healthy behaviours. Overall, the technologies and interventions discussed in this chapter aim to build on treatment adherence of patients in different health areas, with the hope of developing stronger clinician and patient relationships and promoting patient independence.

3. Methods

This methods section has two parts: a background to the design of the infographics, which constitute this thesis' creative component, and the methodology used in the survey, which forms the basis of the academic component of this thesis.

3.1 Background Preparation for Infographic Design

Infographic construction involved a significant amount of preparation and understanding of graphic design. Limited experience of design was carried into this project, and therefore consulted with Denise Narciso (Research and Teaching Assistant) from the Otago Polytechnic School of Design in design communication. Narciso outlined the process of producing high-quality graphics and the use of vector graphic design software, Adobe Illustrator Creative Cloud 2017 (ICC). A part of the design process involved studying health infographics and collating an Inspiration Folder.

Meetings were organised with staff members from the University of Otago Department of Human Nutrition to source reliable information in relation to the mechanisms of different food constituents, food types, and beverages, about CRC risk. Staff members suggested the World Cancer Research Fund International (WCRFI) reports as the primary data source. The reports described all cancer types and risk factors outside nutrition such as exercise and smoking.

Each infographic (eight in total) underwent multiple drafts and reviews to ensure science content accuracy before survey administration. Academic staff members from the University of Otago's Department of Human Nutrition, Department of Microbiology and Immunology, and Dunedin School of Medicine evaluated the graphics. Moreover, a lead reviewer from the Ministry of Education of the New Zealand Government assessed the clarity of the information communicated.

3.2 Information Sources for Infographic Content

The designed infographics contained information primarily sourced from the WCRFI. The WCRFI operates an ongoing programme called the Continuous Update Project (CUP) to examine how nutrition influences cancer risk. CUP is an authoritative scientific resource that supports present guidelines and policies for cancer prevention. CUP's 2017 Colorectal Cancer Report (World Cancer Research Fund, 2017) prioritises the risk of different food types, food constituents, and beverages against CRC.

The National Cancer Institute (NCI) provided data sheets on the number of standard drinks to increase CRC risk for a regular drinker (National Cancer Institute, 2013). The NCI is a cancer research organisation dedicated to reducing cancer burden and the United States of America's primary source for cancer research.

The New Zealand Nutritional Foundation (NZNF) is a professional organisation that produces reliable information about food and how it impacts human health. NZNF supplied examples of high fibre based foods for the infographics (New Zealand Nutrition Foundation, 2017).

3.3 Design Software

This project used ICC 2017 (version 22.0.0) to construct infographics. The software stocked multiple colour themes through Adobe Colour Creative Cloud (CCC), with each theme viewing at least five colours that combine. Also, the software connects with Adobe Typekit to allow access to multiple designer fonts. The Creative Cloud Tutorials application (version 2.4.5) for iPads provided teaching on ICC 2017 and how to amalgamate the different Adobe systems.

Following construction of the static infographics, the design processed used Apple's Keynote (version 7.3.1) to animate the infographics with various animation types. Keynote's Build Order function structured the sequence of animations and offered the ability to alter animation speed, duration, and commencement. The Apple website provided tutorials on how to use the animation tools (Apple, 2017) efficiently.

3.4 Guiding Principles

In constructing the infographics, emphasis was placed on showing the cellular interactions between the human body and different types of consumables. The rationale with selected images was to reveal to audiences the multiple human elements and processes involved with CRC prevention and risk. Signifying this kind of information was difficult to relay as it is rarely seen by the human eye (requires a microscope) and standard methods of communication (such as textbooks) hindered the ability to view dynamic microscopic structures (McClean et al., 2005). Ginossar (2016) mentioned that lack of preventive information released about cancer to the public and therefore, provided the motivation of this thesis to design the infographics with dietary information. Furthermore, Fagerlin et al. (2011) recommended use of pictographs and basic language terms was considered in the design of the infographics for clarity and understanding.

Each infographic commonly included a statement of what is CRC, examples of the particular consumable, the key reactant to increase risk or decrease CRC risk in each consumable, how does the reactant interact with the human body, and how the bodily interaction leads to an increase or decrease risk of CRC. Inclusion of this content aimed to exhibit a logical progression for viewers to easily retain the information. Providing an opening statement on what is CRC aimed to build a viewer's health literacy which may motivate an individual to take action such as CRC screening (Miller et al., 2007). Additionally, the statement provides an introduction to what the infographic was regarding about. An image of a bowel was used to indicate viewers the location of the cancer in the body. The examples of the consumables were used to support viewers to help them familiarise with the consumables seen in local markets (for example the calcium infographics illustrated milk and yogurt). The aim of each infographic was to reveal the particular substance within each consumable and display how it interacts with the human cells. Therefore, images of molecules and cells were frequently designed along with the application of animations, which intended to give viewers a sense that a dynamic process was involved.

3.5 Design Process

This project comprised of eight infographics, a static and an animated version of each of the two high risks (alcoholic drinks and processed meat) and two protective (calcium and fibre). A paper sketch of each image produced an initial concept design, followed by a digital image construction. ICC set static infographics dimensions to 800 pixels (width) by 2048 pixels (height) to keep within uploading parameters of the survey design software and social media websites. ICC exported static infographics as Portable Network Graphics (PNG) to retain high-resolution, with animations exported as MPEG-4 video formats.

3.5.1 Font and Colour Selection

Between the four infographics, ICC applied three fonts from Adobe Typekit. Alcoholic drinks and fibre infographics used the FatFrank Heavy (Figure 2A) font whereas calcium and processed meat utilised the Serenity Demi Bold (Figure 2B) font. Additionally, processed meat used HWT Arts Regular (Figure 3C) for titles to illustrate a negative danger theme as a risk food.

Figure 2: Font Examples. (A) FatFrank Heavy font. (B) Serenity Demi Bold font. (C) HWT Arts Regular font.

This project selected four colour panels to illustrate a particular theme for each infographic. To expand the danger theme mentioned earlier, CCC applied the Welcome Meats (Figure 3A) colour panel for the processed meat infographic. Alcoholic drinks used the Heineken 1 (Figure 3B) colour panel to imitate beer brands like Heineken and Steinlager. For the protective infographics, calcium used the Milk

(Figure 3C) colour panel to show a dairy theme, and the dietary fibre infographic used the Vegetable (Figure 3D) colour panel to deliver a nature theme. Some images required colours outside the panel for audiences to quickly identify with (e.g. the Milk colour panel had no green but needed it for the Broccoli image). Furthermore, some colours underwent changes in colour tone for a clear contrast between colours.

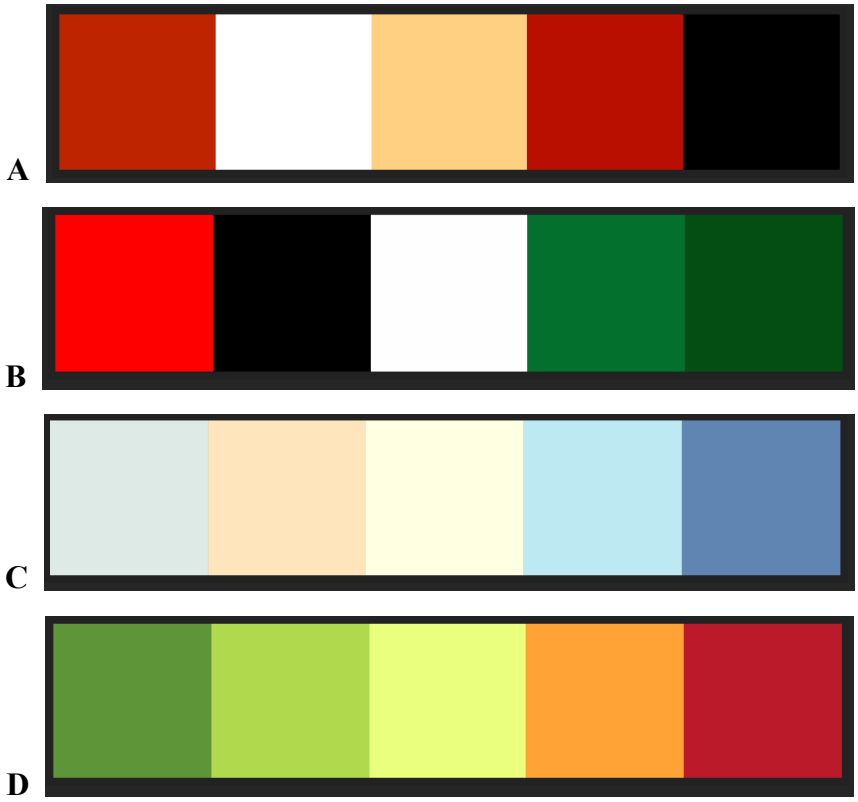


Figure 3: Colour Panels. (A) Welcome Meats. (B) Heineken1. (C) Milk. (D) Vegetables.

3.5.2 Animations

The final design process involved Keynote breaking up each infographic into slides to read the content clearly and avoid lagging of animations. Appendix A of the thesis contains dimensions of each video. Each video incorporated a five-second delay and extended animation time to ensure audiences would view each animation. The display time of each slide remained between 15 - 20 seconds depending on content and animation speed. The survey design software included a replay function for viewers to watch the video again.

3.5.3 Content Reviewers

Health professionals from related disciplines and a reviewer from the Ministry of Education reviewed the content, comprehensibility, and imagery of each infographic. Appendix B lists each health professional and the reviewer's name, position, and their organisation. Additionally, lay members who have previously been affected by CRC reviewed the infographics.

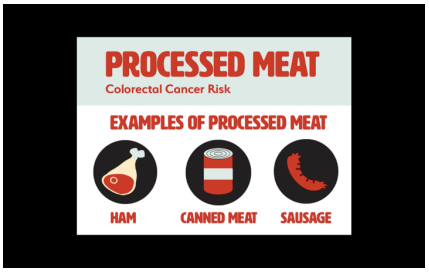
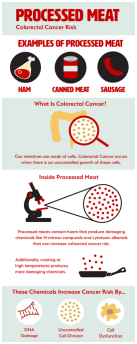
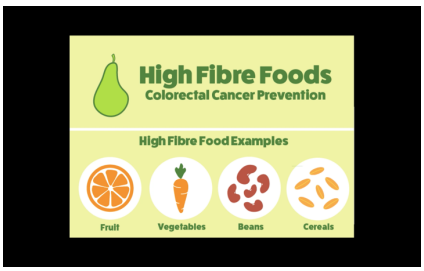
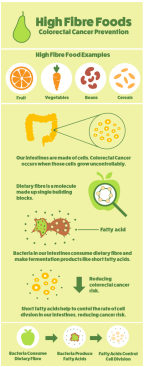
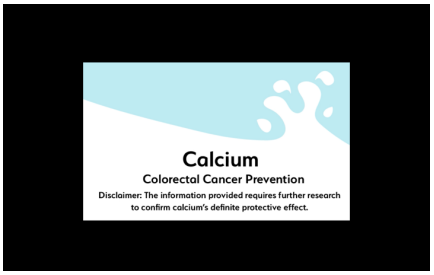
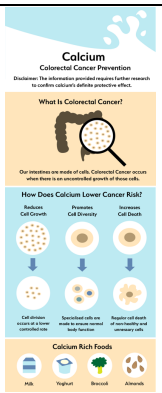
3.6 Survey Design

This project used Qualtrics (Version November 2017) to design and administer surveys along with Amazon Mechanical Turk (mTurk) for participant recruitment. mTurk is an online labour market designed by Amazon to employ and renumerate workers to complete computer-based activities (Paolacci & Chandler, 2014). IBM Statistical Package for the Social Sciences (SPSS) (Version 24) applied statistical analysis of data sets and used Microsoft Excel For Mac 2011 (Version 14.3.9) to design box and whisker graphs to display average scores.

Eight surveys ran in parallel to examine the overall effectiveness of animated and static infographics. mTurk created eight different "HITs" or tasks which correspond to one of the eight surveys. The HITs were released to the mTurk workers who selected one of the eight HIT's to complete. Each HIT remained open to workers until the target completion number for the particular HIT was reached. This project assessed two risk factor groups (processed meat and alcoholic drinks) and two protective factor groups (fibre and calcium) that formed a total of eight infographics (one animated and one static for each group) (Table 1).

Each survey asked nine multiple choice questions to determine content understanding of each infographic and correct answers provided a score out of nine for each participant. The questionnaire followed up with demographic questions (age, ethnicity, education, and gender) and questions on any prior knowledge of CRC (heard of the term or personally know someone that has the condition). Appendix C contains each survey in full.

Table 1: Overview of infographics for survey design (Refer to Appendix D for full static sizes).

	Animated	Static
Alcoholic Drinks (Risk Factor)		
Processed Meat (Risk Factor)		
Fibre (Protective Factor)		
Calcium (Protective Factor)		

3.7 Project Hypotheses

This thesis considered six hypotheses:

H1: Animated infographics viewers would obtain a higher average score compared to static infographic viewers when evaluating dietary information for CRC prevention.

Animated infographics are hypothesised to communicate information better than static infographics because of its ability to support long-term retention (O'Day, 2007).

H2: Participants who view risk infographics would obtain a higher average score compared with those who view infographics on protective factors when evaluating dietary information for CRC prevention

Risk factor infographics are hypothesised to communicate health information better than protective inforgraphics because risk information engages viewers more (Strekalova & Krieger, 2017).

H3: The 65 years and over age group was hypothesised to have a higher average score compared to other age groups when viewing dietary information for CRC prevention.

The 65 years and over age group is hypothesised because the age group with the highest incidence would expect to score higher. The median age for colorectal cancer diagnosis is 68 for men and 72 for women (American Cancer Society, 2017).

H4: Europeans would gain a higher average score compared to other ethnic groups when viewing dietary information for CRC prevention.

Europeans is hypothesised because of evidence showing the positive response to healthy eating to reduce CRC risk (Van Duijnhoven et al., 2009).

H5: Participants who have knowledge of CRC would gain a higher average score compared to unfamiliar individuals when viewing dietary infographics for CRC prevention.

Participants who have knowledge of CRC are hypothesised to understand infographics better than individuals who have not heard of CRC because they are more familiar with the information (Zeitoun and Shemesh, 2017).

H6: Individuals who know someone personally with CRC would obtain a higher average score compared to unconnected individuals when viewing dietary information for CRC prevention.

Participants who personally know someone with CRC are hypothesised to understand infographics better than unconnected individuals because they are more familiar with the information (He et al., 2017).

3.8 Statistical Analysis

For hypothesis 1, data analysis involved comparing average scores between animated and static viewers within each consumable group. Additionally, this project analysed the combined animated and static scores from both risk and protective groups. SPSS performed a Levene's Test to determine equal variances of data followed by an Independent Samples T-test to compare the means of two groups.

For hypothesis 2, Data analysis involved comparing average scores between risk and protective infographic viewers. SPSS performed a Levene's Test to determine equal variances of data followed by an Independent Samples T-test to analyse the means of two groups.

For hypothesis 3, this project questioned each participant's age group and compared average scores between groups. SPSS performed a Welch T-test because the data displayed unequal variances between age groups in response to the Levene's Test.

For hypothesis 4, this project sought each participant's ethnicity and compared average scores between the ethnic groups. SPSS performed a Welch T-test because the data displayed unequal variances between age groups in response to the Levene's Test.

For hypothesis 5, the survey questioned each participant's prior knowledge of CRC to determine whether the infographics would build on existing knowledge. This study analysed average scores among individuals who have heard of CRC compared to individuals who have not. SPSS performed a Levene's Test to test for equal variances of data followed by an Independent T-test to examine the means of the two groups.

For hypothesis 6, the survey questioned each participant on whether they knew anyone with CRC to examine whether the infographics would affect their comprehension. Data analysis compared average scores between individuals who know someone with CRC compared to individuals who do not know anyone with CRC. SPSS performed a Levene's Test to test for equal variances of data followed by an Independent Samples T-test to analyse the means of two the groups.

To avoid compromised results, Qualtrics applied the Prevent Ballot Box Stuffing feature to halt repetition of the survey. Additionally, Qualtrics incorporated the Force Response function to ensure each participant answered every question for survey completion. The survey asked each participant of any previous involvement with Otago University surveys. If the participant responded, "Yes" to the question, then Qualtrics would automatically direct the participant to the end of the survey, thereby limiting participants from being involved in other infographic surveys. The survey incorporated a supplementary question of "Please select the number 7" to ensure the attention of participants. Furthermore, this study removed participants who spent less than two minutes (static infographic) or three and a half minutes (animated infographic) as this was deemed unreasonably quick. Questionnaires underwent duration testing and content reviewing before being released online.

All surveys included an Ethics Approval Number (D17/375) and a statement of approval from the University of Otago Ethics Committee. For each questionnaire, mTurk targeted 125 participants per infographic and received an amount of 0.25 cents after survey completion in line with standard practice (Carter et al., 2014).

4. Results

This study surveyed a total number of 1,921 participants. After taking into account completion times and answers to supplementary questions (please select the number 7 and any previous involvement with any University of Otago surveys), the final sample size was 1,011 in total between the eight arms.

Table 2: Summary of Participant Group Numbers

	Animated	Static
Alcoholic Drinks	125	131
Processed Meat	121	128
Fibre	121	129
Calcium	124	132
Total	1011	

Table 3: Gender Group Numbers for Study Population

	Number of Participants
Male	508
Female	503
Total	1011

Table 4: Age Group Numbers for Study Population

	Number of Participants
18 - 29 Years of Age	412
30 - 49 Years of Age	483
50 - 64 Years of Age	89
65 Years and Over	27
Total	1011

Table 5: Ethnicity Group Numbers for Study Population

	Number of Participants
European	216

North American	311
South American	32
Indian	360
Chinese	11
Other Asian	57
African	36
Pacific Islander	4
Oceania	1
Total (Some participants affiliate with other ethnicities as well).	1028

Table 6: Education Group Numbers for Study Population

	Number of Participants
Attended High School	8
High School Graduate	158
Trade / Technical / Vocational training	98
University Undergraduate	507
Postgraduate	236
Prefer Not to Answer	4
Total	1011

4.1 No Difference Between Animated and Static Infographics

SPSS compared comprehension scores out of nine within each risk and protective group, and also analysed the combined scores of the four animated arms with the combined scores of the four static arms. The results falsified the hypothesis with no consistent difference between animated and static infographics (Figure 1). Within each risk and protective group and the combined total, SPSS obtained p-values over 0.05 through Independent Samples T-tests.

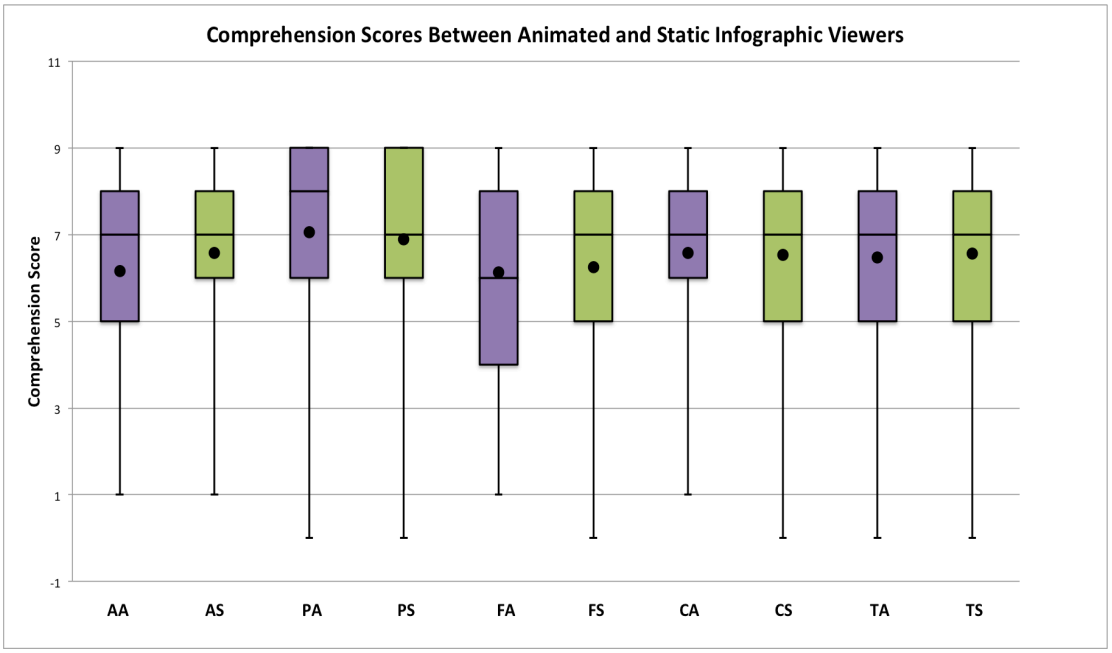


Figure 1 Average comprehension scores of participants between animated and static infographic viewers. Alcoholic Drinks: Animated (AA) and Static (AS). N (AA) = 125, N (AS) = 131, Levene's Test significance value = 0.676, p-value = 0.073. Processed Meat: Animated (PA) and Static (PS). N (PA) = 121, N (PS) = 128, Levene's Test significance value = 0.339, p-value = 0.526. Fibre: Animated (FA) and Static (FS). N (FA) = 121, N (FS) = 129, Levene's Test significance value = 0.908, p-value = 0.667. Calcium: Animated (CA) and Static (CS). N (CA) = 124, N (CS) = 132, Levene's Test significance value = 0.133, p-value = 0.867. Total: Animated (TA) and Static (TS). N (TA) = 491, N (TS) = 520, Levene's Test significance value = 0.827, p-value = 0.532. All dataset underwent Independent Samples T-tests. The figure shows one representative experiment.

Table 7: Statistical Data Comparing Animated and Static Infographics

	Standard Deviation		Mean		95% Confidence Interval	
	Animated	Static	Animated	Static	Lower	Upper
Alcohol	1.89	1.84	6.15	6.57	-0.039	0.88
Processed Meat	2.23	2.12	7.05	6.88	-0.719	0.368
Fibre	2.11	2.16	6.12	6.24	-0.416	0.649
Calcium	1.90	2.11	6.57	6.53	-0.538	0.453
Total	2.07	2.07	6.47	6.56	-0.174	0.336

4.2 Risk Infographics Viewers Scored a Higher Average Compared to Protective Viewers

SPSS analysed scores of between the risk (alcoholic drinks and processed meat) and protective (calcium and fibre) groups. The findings supported the hypothesis with a higher average score from risk infographic viewers of 6.7 compared to protective viewers of 6.4 (Figure 2). The data displayed equal variances and a T-test p-value of 0.024.

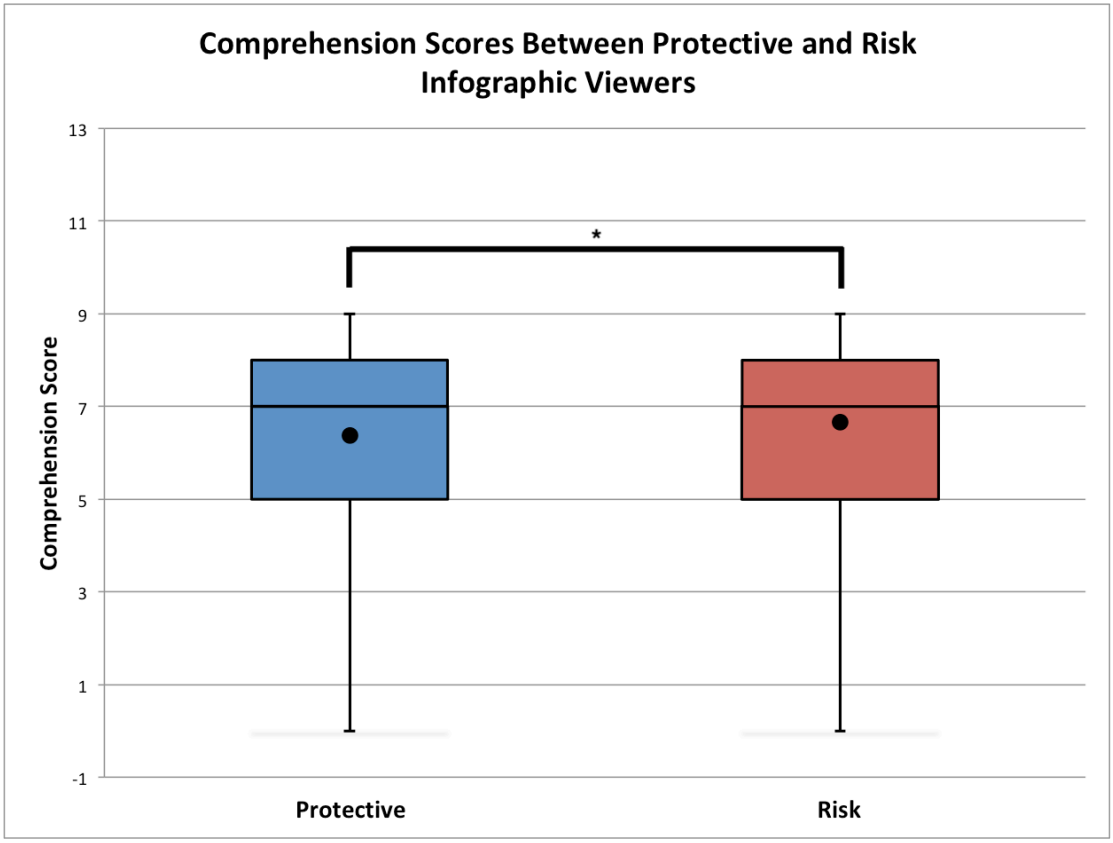


Figure 2 Average comprehension scores of participants between protective and risk infographic viewers. Dataset included scores from each animated and static viewers. N (Protective) = 506, N (Static) = 505, Levene's Test significance value = 0.380, p-value = 0.024. Dataset underwent Independent Samples T-tests. The figure shows one representative experiment.

Table 8: Statistical Data Comparing Protective and Risk Infographics

Standard Deviation		Mean		95% Confidence Interval	
Protective	Risk	Protective	Risk	Lower	Upper
2.08	2.05	6.37	6.66	0.039	0.548

4.3 Increasing age Correlates with Higher Average Scores

The third hypothesis stated the 65 years and over age group would obtain a higher average score compared to other age groups. SPSS performed a Welch T-test and Games Howell post hoc because the data set displayed unequal variances to compare scores between age groups. The study supported the hypothesis with the 18 - 29 age group scored an average of 6.1, the 30 – 49 age group scored an average of 6.7, and the 50 – 64 age group scored an average of 7, which are all lower than the 7.7 average from the 65 years and over group (Figure 3). The Welch T-test and Games Howell post hoc confirmed p-values less than 0.001 between age groups associated with the 18 – 29 age range, along with a p-value of 0.003 between the 30 – 49 and 65 years and over age groups.

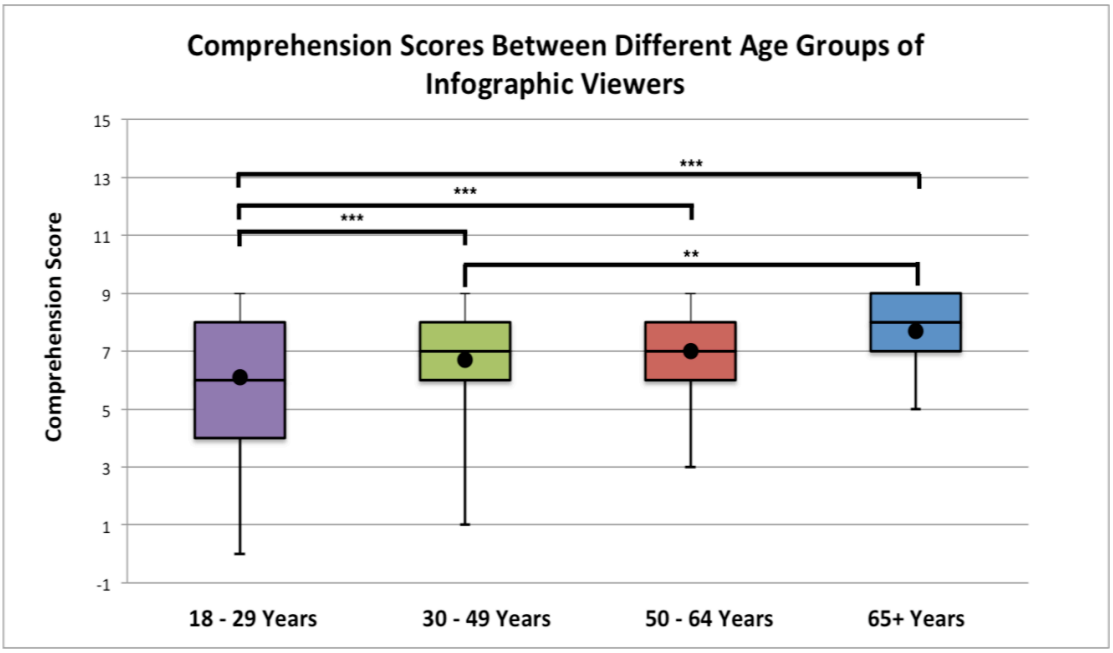


Figure 3 Average comprehension scores of participants between age groups. Dataset included comprehension scores from each animated and static infographic viewers. N (18 – 29 Years) = 412, N (30 – 49 Years) = 483, N (50 - 64 Years) = 89, N (65 Years and Over) = 27, Levene's Test significance value = 1.16×10^{-8}, Welch T-test: p-value = 3.13×10^{-8}. Games Howell: p-value (18 – 29 / 30 – 49 Years) = 1.24×10^{-4}, p-value (18 – 29 / 50 – 64 Years) = 2.69×10^{-4}, p-value (18 – 29 / 65 Years and above) = 6×10^{-6}, p-value (30 – 49 / 50 - 64 Years) = 0.452, p-value (18 – 29 / 65 Years and above) = 3.48×10^{-3}, p-value (50 - 64 Years / 65 Years and above) = 0.127. Dataset underwent Welch T-test followed by Games Howell post hoc between age groups. The figure shows one representative experiment.

Table 9: Statistical Data Comparing Age Groups

	Standard Deviation	Mean	95% Confidence Interval	
18 – 29 Years	2.3	6.10	5.88	6.33
30 – 49 Years	1.87	6.71	6.54	6.88
50 – 64 Years	1.74	7.01	6.64	7.38
65 Years and Over	1.3	7.70	7.19	8.22

4.4 Indians Showed a Lower Average With Europeans and North Americans

The results supported the fourth hypothesis with a lower average score observed with Indians compared to Europeans and North Americans. Indians obtained an average of 6.1 compared to the Europeans with 7 and North Americans with 6.7 (Figure 4). SPSS performed a Welch T-test and Games Howell post hoc because the entire data set displayed unequal variances to compare scores between age groups. The Welch T-test and Games Howell post hoc confirmed p-values between Indians and North Americans with 5.7×10^{-5} and Indians with Europeans with 2.8×10^{-3}.

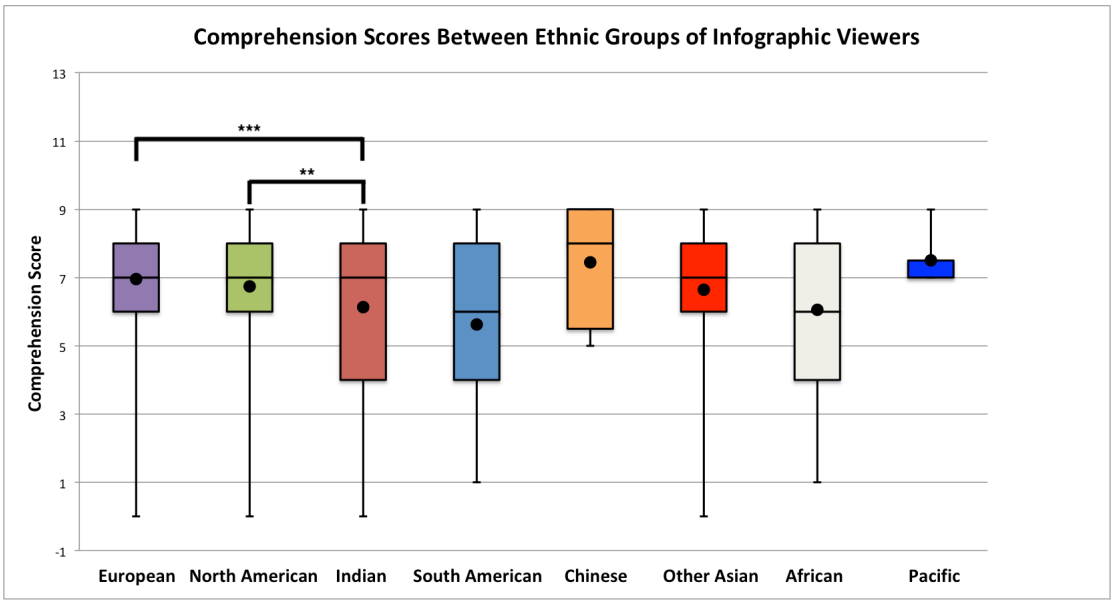


Figure 4 Average comprehension scores of participants between ethnic groups. Dataset included comprehension scores from each animated and static infographic viewer. N (European) = 216, N (North American) = 311, N (Indian) = 360, N (South American) = 32, N (Chinese) = 11, N (Other Asian) = 57, N (African) = 36, N (Pacific) = 4. Levene's Test significance value = 7.04×10^{-7}, Welch T-test: p-value = 3.63×10^{-4}. Games Howell: p-value (Indian / North American) = 2.8×10^{-3}, p-value (Indian / European) = 5.7×10^{-5}. Dataset underwent Welch T-test followed by Games Howell post hoc between ethnic groups. The figure shows one representative experiment.

Table 10: Statistical Data Comparing Ethnicity Groups

	Standard Deviation	Mean	95% Confidence Interval	
European	1.83	6.96	6.71	7.20
North American	1.80	6.74	6.54	6.94
Indian	2.26	6.13	4.71	6.37
South American	2.55	5.63	5.9	6.54
Chinese	1.81	7.45	6.24	8.67
Other Asian	2.24	6.65	6.06	7.24
African	2.24	6.06	5.3	6.81
Pacific	1	7.5	5.91	9.09

4.5 'Knowledge' Participants Scored Higher Compared To Other Participants

The fifth hypothesis stated individuals who have heard of CRC would score a higher average compared to other participants. SPSS administered an Independent Samples T-test to compare comprehension scores between the two groups. The findings supported the hypothesis with the 'knowledge' participants obtaining a higher average mark of 6.9 compared to other participants with 6.1 (Figure 5). The Independent Samples T-test provided a p-value of 1.27×10^{-10}.

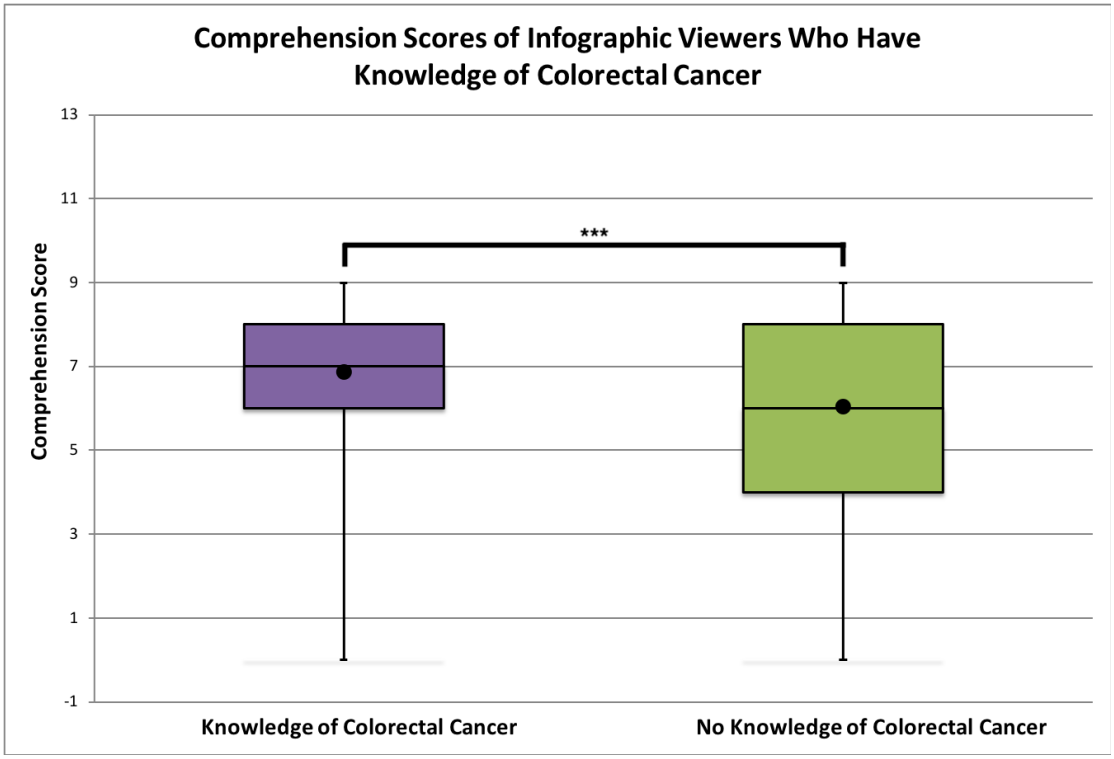


Figure 5 Average comprehension scores of participants between 'knowledge' and unheard CRC viewers. Dataset included scores from each animated and static viewer. N (Knowledge) = 564, N (No

Knowledge) = 447, Levene's Test significance value = 4.4 x 10^{-5}, p-value = 1.27 x 10^{-10}. Dataset underwent an Independent Samples T-test. The figure shows one representative experiment.

Table 11: Statistical Data Comparing Knowledge and No Knowledge Individuals

Standard Deviation		Mean		95% Confidence Interval	
Heard	Unheard	Heard	Unheard	Lower	Upper
1.89	2.18	6.88	6.05	-1.09	-0.58

4.6 Non-personally Connected Participants Showed Greater Understandings Than Connected Individuals

This project falsified the sixth hypothesis by identifying the non-personally connected individuals gaining a higher average score of 6.6 compared to the connected individuals of 6.1 (Figure 6). SPSS administered an Independent Samples T-test to compare comprehension scores between the two groups and determined a p-value of 0.018.

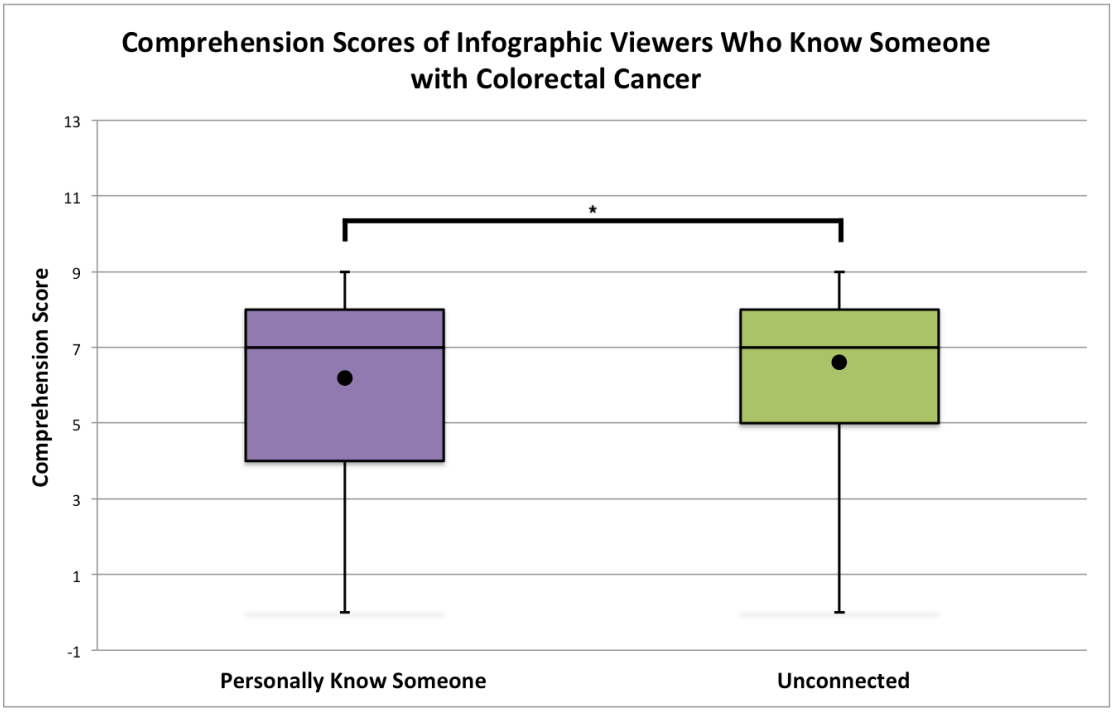


Figure 6 Average comprehension scores of individuals who know someone with CRC or not. Dataset included scores from each animated and static infographic viewer. N (Personally Know Someone) = 205, N (Unconnected) = 806, Levene's Test significance value = 0.005, p-value = 0.018. Dataset underwent an Independent Samples T-test. The figure shows one representative experiment.

Table 12: Statistical Data Comparing Personally Connected or Unconnected Individuals

Standard Deviation		Mean		95% Confidence Interval	
Personally Know	Unconnected	Personally Know	Unconnected	Lower	Upper
2.29124	1.99731	6.1854	6.6005	0.071	0.759

Additional data on gender and education groups are located in Appendix E. No variability was observed within those groups.

5. Discussion

This study compared average scores between animated and static infographic viewers and identified no variability between the two groups (Figure 1). On the other hand, risk infographics viewers showed a better recall of infographic information than protective infographic viewers (Figure 2). This project also evaluated specific demographic groups and their responses to infographics. Older individuals showed a greater knowledge of cancer risk information (Figure 3) whereas Indians retained less information compared with Europeans and North Americans (Figure 4). Individuals who have knowledge of CRC obtained a higher average score compared to individuals who have not heard of CRC (Figure 5). Interestingly, individuals who have no personal connection with CRC individuals showed a better understanding of the infographic content (Figure 6).

5.1 Focus on Infographic Content as Oppose to Infographic Medium

For effective cancer and dietary communication, infographic designers need to focus more on content as opposed to the type of infographic. A review mentioned the lack of evidence to show the robustness of computer animations for general health communication, and our study suggest such animation may be of less importance than the choice of content framing (Ruiz et al., 2009). The design of useful cancer infographics using simplistic and minimalistic information can further a viewer's understanding (Zikmund-Fisher et al., 2012). Zikmund-Fisher et al. (2012) assessed 4,198 individuals and their treatment decision-making ability to a dynamic or still risk graphic on thyroid cancer. The study concluded participants displaying increased knowledge and better precision of treatment choice from still graphics. This project identified no difference between the effectiveness of animated and static infographics. This challenges the conclusion from O'Day (2007), who stated that animated graphics are beneficial in health communication. The strength of animations remains inconsistent with health communication. Daly et al. (2016) assessed the effectiveness of animations to communicate vascular neuroeffector transmission between two health science classes (physiology and pharmacology). The study showed variability in results with the pharmacology students responding better to the animations (p-value of 0.04) although no difference was observed within the physiology students.

Additionally, no difference was seen when the results of the two classes were combined. One significant difference is that O'Day assessed the effectiveness of such graphics for students, where as this study considered a more general audience; the kind of audience most likely to be targeted by health infographics.

5.2 Communicating Negative Risk Information on Infographics

Building from the previous point that infographics designers should focus on infographic content, this project identified negative risk information to be a more beneficial frame for effective cancer and dietary communication (Figure 2). This is in keeping with the literature. The NCI ran a study on their Facebook page to observe responses from their followers (Strekalova & Krieger, 2017). Strekalova and Krieger (2017) found a higher amount of risk-related messages associated with Facebook likes, comments and shares compared to non-risk messages. Furthermore, the study found videos did not increase viewer engagement compared to standard images, which further supports that viewers are more focused on content as opposed to the medium by which information is communicated. Infographic designers should aim to include specific colours and images that impart negative emotions as they can enhance working memory (Xie & Zhang, 2016). Additionally, danger icons and negative images are often prioritised and command greater attention compared to standard icons (Tao et al., 2017). The Tao et al. (2017) study found warning icon viewers were distracted longer for a time of 69ms compared to ordinary icon viewers of 35ms. When designing health infographics, a low amount of positive imagery should be applied as it could impair memory and attention, as illustrations appear unrealistic (Fung et al., 2014).

5.3 Target Older Individuals for Colorectal Cancer Communication

In this study, the older age groups better understood cancer risk infographics compared to the youngest age group (18 to 29 years of age) (Figure 3). In designing CRC infographics, targeting adults of at least 40 years is recommended because of the higher number of diagnosed cases, which tend to arise from this age (Cancer Research UK, 2016). More than 90% of CRC cases occur from the age of 50 years and above,

additionally the incidence rate is 50 times higher between individuals 60 – 79 years of age compared to individuals who are 40 years and younger (Haggar & Boushey, 2009).

One of the main reasons the number of CRC cases is high within older individuals is the prolonged exposure to CRC risk factors compared to younger individuals. CRC infographics require information about healthy eating and regular physical exercise to inform elderly individuals. A study interviewed CRC survivors (average age of 69 years) for two years when under treatment and mentioned the survivors lacked information on healthy dieting and physical activity (Hardcastle et al., 2017). Hardcastle et al. (2017) further supports the New Zealand studies mentioned in the literature review about the lack of nutritional information for CRC patients (Pullar et al., 2012) (Cha et al., 2012), which justified creating dietary infographics for this project.

Another reason for the high number of cases within this age group is the lack of CRC screening within elderly individuals (Al-Azri et al., 2017). In targeting this age group, infographics should aim to present more information on screening programmes and colonoscopy for early detection of CRC. Al-Azri et al. (2017) recruited 405 participants with an average age of 35 and identified 93.6% of participants were unaware of any CRC screening programmes. Furthermore, 98.3% of individuals have not carried out screening for CRC, and only 52.6% of individuals would undergo colonoscopy with a clinician.

5.4 Associate Cancer Infographics With Other Primary Information Sources

This project showed individuals who have heard of CRC previously scored a higher average mark compared to unheard individuals (Figure 5). Infographics should aim to be regularly associated with other sources of cancer information to build on existing CRC knowledge, encourage patient management and decision-making. The literature review described multiple cancer information sources (1.2.2 Electronic Communication In Cancer (The Internet and Mobile Phones)) where individuals are not restricted solely to their primary health care provider for information. Cancer

infographics could potentially integrate with decision aids to motivate older individuals to undergo screening procedures. Decision aids combine the use of animations and graphics to inform individuals about CRC and the benefits of screening (Schroy et al., 2011). Primary health care providers support the use of decision aids as it builds patient knowledge, encourages appropriate decision-making, and increases the desire for patients to undergo screening (Schroy et al., 2014).

5.5 Limitations

One of the limitations for this study was no simplistic quantifiable standard measure for fibre and calcium. Individuals who pursue a diet change in response to the infographics would find it challenging to simply quantify fibre and calcium and therefore, making it difficult to ascertain how much change is required for their personal diet. In the context of dietary fibres, they are considered a mixture of chemical elements. The selection of fibre measurement is heavily dependent on the chemical make-up of the particular fibre and thus, a variety of measurements is required to precisely determine the fibre composition (Elleuch et al., 2011). For calcium, the chemical analysis of spectrometry is required to measure the calcium composition in foods (Sergiel & Pohl, 2010). On the other hand, the World Cancer Research Fund recommended no more than 500 grams of processed meat per week to avoid the risk of CRC. The National Cancer Institute describes approximately regular drinkers who consume 3.5 standard drinks a day have a 1.5 times more likely chance of obtaining CRC compared to non-drinkers (National Cancer Institute, 2013).

A secondary limitation is the potential bias that the study population is not representative of the CRC population at risk. 73.5% of the study population were involved in some sort of tertiary education (undergraduate or postgraduate qualification) and therefore, more likely to have knowledge of CRC and bias a higher comprehension score from the surveys. The third hypothesis mentioned the population at risk was the age group 65 years and over. Although, only 2.7% of the study population represented the 65 years and over age group. Thus, the study population is not an accurate representation for the population at risk.

5.6 Future Directions

5.6.1 Build Younger Individuals and Their Knowledge

In future experiments, infographics should aim to target young adults to be more aware of CRC prevention and screening procedures. Studies have shown university undergraduate students do not carry a strong knowledge of CRC and screening (Mhaidat et al., 2016; Imran et al., 2016). These studies support the finding in this project with the 18 – 29 age group scoring the lowest average score when viewing infographics compared to the older age groups (Figure 3). Mhaidat et al. (2016) suggested the design of education programmes and campaigns to increase awareness and early detection of CRC. Infographics could potentially be associated with outreach programmes to build CRC awareness within communities. Even though the risk of CRC is lower for young adults, the incidence rate is increasing for this age group (Singh et al., 2014). Young adults have a greater luxury of time before the occurrence of CRC symptoms and therefore, have the opportunity to apply preventive habits to reduce their cancer risk later in life. Future projects should consider this age group more strongly to reduce CRC burden within older individuals.

5.6.2 Introducing Interactive Features

Future design of health infographics should integrate interactive features for greater viewer engagement. This project lacked the ability for viewers to interact with the designed infographics. The literature review mentioned inviting online interactive elements and the utilisation of smartphone applications for cancer communication and engagement (Fishbein et al., 2017; Taveira-Gomes et al., 2016). Merging infographics with smartphone applications allows greater public accessibility and encourages activities of healthy eating and physical exercise (Serrano et al., 2017). In designing smartphone applications, they require simple graphics that promote a call to action for viewers (Constantinescu et al., 2017). Furthermore, Constantinescu et al. (2017) described the use of a tracking function to monitor users and their accountability to specific activities. Infographics can extend their applications to increase awareness and improvement patient management of disease by incorporating these technologies.

Conclusion

In conclusion this thesis found that less emphasis should be placed on the type of infographic medium to communicate health information, and rather focus on the kind of information is presented. Presenting risk information has been shown to lead to greater retention of dietary information for CRC prevention than presenting protective information. The message combination of consuming more fibre and calcium and less processed meat and alcohol will likely lead to greater health benefits. Although, individuals should consider their dietary lifestyle and decide the specific food groups require more or less consumption. CRC infographics should continue to target adults 30 years and over as they are more receptive to this type of communication and more at risk of the disease. Finally, infographics should consider combining with other primary sources of CRC information such as decision aids and clinicians to reinforce the importance CRC prevention. There is an expectation that individuals who viewed the infographics would aim to consume more fibre and calcium-based foods along with less processed meat and alcohol consumption. The infographics should encourage discussion with health providers on devising strong health behaviours and habits for cancer prevention.

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Appendix

Appendix A: Video Dimensions

	Height (Pixels)	Width (Pixels)
Alcoholic Drinks	768	698
Processed Meat	576	800
Fibre	596	837
Calcium	716	716

Appendix B: Content Reviewer Details

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Appendix C: Surveys

Please note the same survey was used for the animated group but the term "information graphic" changed to "animation" in reference to the animation.

Appendix C.1: Alcoholic Drinks

Q1 Welcome to this University Of Otago study. Before commencing, have you completed a "University of Otago" survey before?
a. Yes
b. No

Q2 According to the information graphic, what substance in alcoholic drinks increases the risk of colorectal cancer?

a. Reactive molecules.
b. Ethanol.
c. Sugar.
d. Bacterial Products.

Q3 According to the information graphic, what is the number of standard drinks required to increase colorectal cancer risk for regular drinkers?

a. 4.
b. 3.5.
c. 5.
d. 3.

Q4 According to the information graphic, what is colorectal cancer?

a. A cancer formed on the surface of our skin.
b. Lumps of cells in our stomach.
c. Uncontrolled growth of cells in our intestines.
d. Cells producing harmful products that damage surrounding cells.

Q5 According to the information graphic, how likely is a regular drinker going to get colorectal cancer after consuming 3.5 standard drinks?

a. 2 times.
b. 3 times.
c. 1.5 times.
d. 2.5 times.

Q6 Please select the number "7".

a, 1.
b. 5.
c. 9.
d. 7.

Q7 According to the information graphic, what is an example of a reactive molecule that causes colorectal cancer from alcoholic drinks?

a. Benzene.
b. Acetaldehyde.
c. Acetate.
d. Ethane.

Q8 According to the information graphic, how do reactive molecules increase colorectal cancer risk?
a. Increase cell diversity.
b. Cause DNA damage.
c. Holt's cellular proliferation.
d. Promotes cell death.

Q9 According to the information graphic, what is an example of a reactive molecule that can cause colorectal cancer?

a. Propynyl.
b. Nitrite.
c. Reactive oxygen species.
d. Haem.

Q10 According to the information graphic, how do reactive molecules increase colorectal cancer risk?

a. Promote cell dysfunction.
b. Multiply and create more reactive molecules to damage the intestine.
c. Cause nearby cells to produce damaging products.
d. Absorb water in the intestines, leaving it dehydrated.

Q11 According to the information graphic, alcohol breaks cells apart to do what?

a. Increase blood flow between cells.
b. Allow room for rapid cell division.
c. Increase water flow to rehydrate cells.
d. Increase penetration of damaging molecules into cells.

Q12 What is your Gender?

a. Male.
b. Female.

Q13 What is your age group?

a. 18-29 years old.
b. 30-49 years old.
c. 50-64 years old.
d. 65 years and over.

Q14 What is the highest degree or level of school you have completed?

a. Some high school.
b. High school graduate.
c. Trade/technical/vocational training.
d. University undergraduate/bachelor degree.
e. Post graduate degree.
f. Prefer not to answer.

Q15 What is your ethnicity (can select more than one)?

a. European.
b. North American.
c. South American.
d. Indian.
e. African.
f. Chinese.
g. Other Asian.
h. Pacific Islander.
i. Oceania.

Q17 Have you heard of colorectal cancer before?

a. Yes.
b. No.

Q18 Do you personally know anyone who has or had colorectal cancer?

a. Yes.
b. No.

Appendix C.2: Processed Meat

Q1 Welcome to this University Of Otago study. Before commencing, have you completed a "University of Otago" survey before?
a. Yes
b. No

Q2 According to the information graphic, what is an example of a processed meat?

a. Chicken.
b. Ham.
c. Lamb.
d. Salmon.

Q3 According to the information graphic, what is an example of a damaging chemical that can cause colorectal cancer from processed meats?

a. N-nitroso compounds.
b. Nitric Oxide.

c. Nitride.
d. Pure Nitrogen Gas.

Q4 According to the information graphic, what is colorectal cancer?

a. A cancer formed on the surface of our skin.
b. Lumps of cells in our stomach.
c. Uncontrolled growth of cells in our intestines.
d. Cells producing harmful products that damage surrounding cells.

Q5 According to the information graphic, what substance inside processed meat creates more damaging chemicals?

a. Salt.
b. Meat fat.
c. Haem.
d. Vitamin A.

Q6 According to the information graphic, what process enhances the production of more damaging chemicals?

a. Freezing.
b. High temperature cooking.
c. Thawing.
d. Curing.

Q7 Please select the number "7".

a. 1
b. 5.
c. 7.
d. 9.

Q8 According to the information graphic, what is an example of a damaging chemical that causes colorectal cancer from processed meats?

a. Acetaldehyde.
b. Benzene.
c. Ethane.
d. Cytotoxic Alkenals.

Q9 According to the information graphic, how do damaging chemicals increase cancer risk?

a. Promotes cell death.
b. Promote cell dysfunction.
c. Fuse with other damaging chemicals to be more toxic.
d. Increases other cells to produce more damaging chemicals.

Q10 According to the information graphic, how do damaging chemicals from processed meat increase cancer risk?

a. Cause DNA damage.
b. Promotes cell death.
c. Increases cell diversity.
d. Holt's cells division.

Q11 According to the information graphic, what is an example of a processed meat?

a. Mince.
b. Eggs.
c. Cheese.
d. Sausages.

Q12 What is your Gender?

a. Male.
b. Female.

Q13 What is your age group?

a. 18-29 years old.
b. 30-49 years old.
c. 50-64 years old.
d. 65 years and over.

Q14 What is the highest degree or level of school you have completed?

a. Some high school.
b. High school graduate.
c. Trade/technical/vocational training.
d. University undergraduate/bachelor degree.
e. Post graduate degree.
f. Prefer not to answer.

Q15 What is your ethnicity (can select more than one)?

a. European.
b. North American.
c. South American.
d. Indian.
e. African.
f. Chinese.
g. Other Asian.
h. Pacific Islander.
i. Oceania.

Q17 Have you heard of colorectal cancer before?

a. Yes.
b. No.

Q18 Do you personally know anyone who has or had colorectal cancer?

a. Yes.
b. No.

Appendix C.3: Fibre

Q1 Welcome to this University Of Otago study. Before commencing, have you completed a "University of Otago" survey before?
a. Yes
b. No

Q2 According to the information graphic, what type of cell consumes dietary fibre?

a. Red Blood Cell.
b. White Blood Cell.
c. Bacterial Cell.
d. Goblet Cell.

Q3 According to the information graphic, what substance interacts with cells to lower colorectal cancer risk?

a. Bacteria.
b. Short Fatty Acids.
c. Dietary Fibre.
d. Fruits & Vegetables.

Q4 According to the information graphic, what is colorectal cancer?

a. A cancer formed on the surface of our skin.
b. Lumps of cells in our stomach.
c. Uncontrolled growth of cells in our intestines.
d. Cells producing harmful products that damage surrounding cells.

Q5 According to the information graphic, which of these is an example of a high dietary fibre food?

a. Beans.
b. Yoghurt.
c. Rice.
d. Bread.

Q6 According to the information graphic, what process do bacteria undergo to lower colorectal cancer risk?

a. Digestion.
b. Expansion.
c. Degradation.
d. Fermentation.

Q7 Please select the number "7".

a. 1.
b. 5.
c. 9.
d. 7.

Q8 According to the information graphic, what is dietary fibre?

a. A part of food that supports the health of bacteria.
b. A part of food formed together by single building blocks.
c. A part of food broken down by our intestines.
d. A part of food absorbed by our cells.

Q9 According to the information graphic, what is the function of short fatty acids with colorectal cancer?

a. Supports red blood cells in transporting oxygen to colorectal cancer cells.
b. Combines with other short fatty acids to reduce room for colorectal cancer growth.
c. Releases signalling products to alert the immune system to destroy colorectal cancer cells.
d. Reduces the rate of cellular division and lowering the chances of colorectal cancer growth.

Q10 According to the information graphic, which of these is an example of a high dietary fibre food?

a. Pasta.
b. Cereals.
c. Milk.
d. Fish.

Q11 According to the information graphic, what are our intestines made of?

a. Cells.
b. Blood.
c. Bacteria.
d. Short Fatty Acids.

Q12 What is your Gender?

a. Male.
b. Female.

Q13 What is your age group?

a. 18-29 years old.
b. 30-49 years old.
c. 50-64 years old.
d. 65 years and over.

Q14 What is the highest degree or level of school you have completed?

a. Some high school.
b. High school graduate.
c. Trade/technical/vocational training.
d. University undergraduate/bachelor degree.
e. Post graduate degree.
f. Prefer not to answer.

Q15 What is your ethnicity (can select more than one)?

a. European.
b. North American.
c. South American.
d. Indian.
e. African.
f. Chinese.
g. Other Asian.
h. Pacific Islander.
i. Oceania.

Q17 Have you heard of colorectal cancer before?

a. Yes.
b. No.

Q18 Do you personally know anyone who has or had colorectal cancer?

a. Yes.
b. No.

Appendix C.4: Calcium

Q1 Welcome to this University Of Otago study. Before commencing, have you completed a "University of Otago" survey before?
a. Yes
b. No

Q2 According to the information graphic, what are our intestines made of?

a. Cells.
b. Blood.
c. Bacteria.
d. Short Fatty Acids.

Q3 According to the information graphic, what is an example of a calcium-rich food?

a. Rice.
b. Broccoli.
c. Bread.
d. Berries.

Q4 According to the information graphic, what is colorectal cancer?

a. A cancer formed on the surface of our skin.
b. Lumps of cells in our stomach.
c. Uncontrolled growth of cells in our intestines.
d. Cells producing harmful products that damage surrounding cells.

Q5 According to the information graphic, what is cell diversity?

a. Where cells consume different food products to increase their longevity.
b. Where cells have the ability to fuse with neighbouring cells to gain different abilities and functions.
c. Where cells release different molecules to lower colorectal cancer risk.
d. Where cells create specialised cells to ensure normal functioning of the body.

Q6 Please select the number "7".

a. 1.
b. 5.
c. 9.
d. 7.

Q7 According to the information graphic, why is cell death important in colorectal cancer?

a. To create space for new cells to carry normal body function.
b. To prevent cancer cells infecting nearby cells and turning them cancerous.
c. To remove unhealthy or unnecessary cells.
d. To release special products that strengthen immune cells to attack cancer cells.

Q8 According to the information graphic, what is the importance of reducing cell growth in colorectal cancer?

a. To ensure the body does not develop too fast.
b. To ensure cell division occurs at a controlled rate.
c. To limit the amount of damaging cell products.
d. To allow strengthening of existing cells.

Q9 According to the information graphic, what is an example of a calcium-rich food?

a. Almonds.
b. Chia Seeds.

c. Sultanas.
d. Capsicum.

Q10 According to the information graphic, what three conditions from calcium lower colorectal cancer risk?

a. Promotes cell growth, promotes cell death, promotes cell diversity.
b. Reduces cell growth, reduces cell death, reduces cell diversity.
c. Promotes cell growth, promotes cell death, reduces cell diversity.
d. Reduces cell growth, promotes cell death, promotes cell diversity.

Q11 According to the information graphic, what did the disclaimer state at the start?

a. The information provided requires further research to confirm calcium's definitive protective effect.
b. The information provided indicates calcium is protective.
c. The information provided states that calcium is unlikely to be protective.
d. The information provided is in the early stages of research to show calcium's protective effect.

Q12 What is your Gender?

a. Male.
b. Female.

Q13 What is your age group?

a. 18-29 years old.
b. 30-49 years old.
c. 50-64 years old.
d. 65 years and over.

Q14 What is the highest degree or level of school you have completed?

a. Some high school.
b. High school graduate.
c. Trade/technical/vocational training.
d. University undergraduate/bachelor degree.
e. Post graduate degree.
f. Prefer not to answer.

Q15 What is your ethnicity (can select more than one)?

a. European.
b. North American.
c. South American.
d. Indian.
e. African.
f. Chinese.
g. Other Asian.

h. Pacific Islander.
i. Oceania.

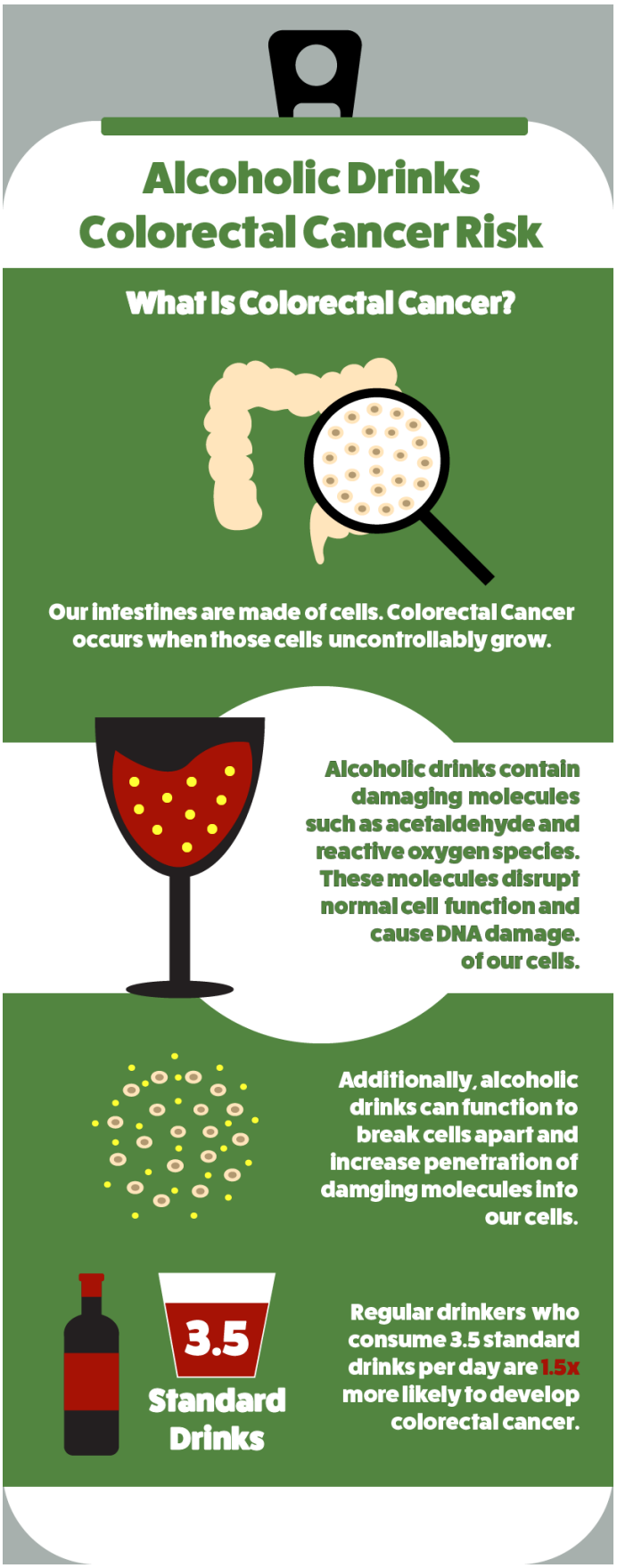
Q17 Have you heard of colorectal cancer before?

a. Yes.
b. No.

Q18 Do you personally know anyone who has or had colorectal cancer?

a. Yes.
b. No.

Appendix D: Static Infographics



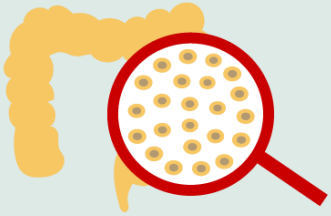
PROCESSED MEAT

Colorectal Cancer Risk

EXAMPLES OF PROCESSED MEAT

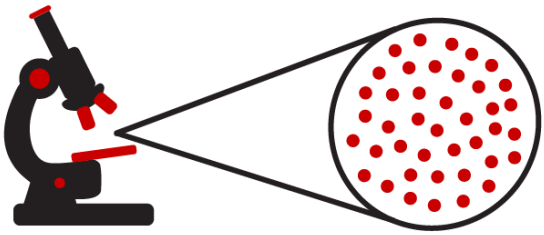
HAM CANNED MEAT SAUSAGE

What Is Colorectal Cancer?



Our intestines are made of cells. Colorectal Cancer occurs when there is an uncontrolled growth of those cells.

Inside Processed Meat



Processed meats contain haem that produce damaging chemicals like N-nitroso compunds and cytotoxic alkenals that can increase colorectal cancer risk.

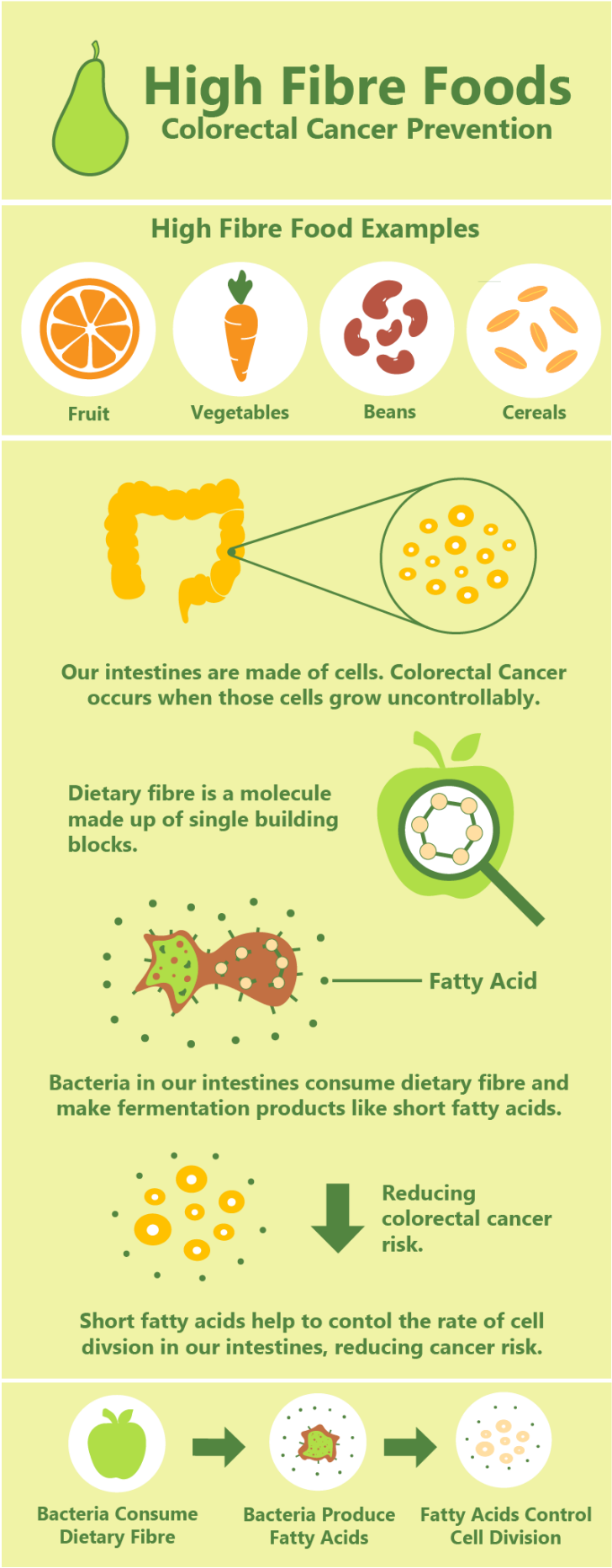
Additionally, cooking at high temperatures produces more damaging chemicals.

These Chemicals Increase Cancer Risk By...

DNA Damage

Uncontrolled Cell Division

Cell Dysfunction

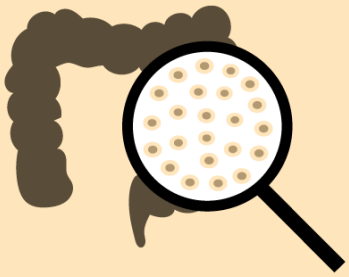

High Fibre Foods
Colorectal Cancer Prevention
High Fibre Food Examples
Fruit
Vegetables
Beans
Cereals
Our intestines are made of cells. Colorectal Cancer occurs when those cells grow uncontrollably.
Dietary fibre is a molecule made up of single building blocks.
Fatty Acid
Bacteria in our intestines consume dietary fibre and make fermentation products like short fatty acids.
Reducing colorectal cancer risk.
Short fatty acids help to contol the rate of cell divsion in our intestines, reducing cancer risk.
Bacteria Consume Dietary Fibre
Bacteria Produce Fatty Acids
Fatty Acids Control Cell Division

Calcium

Colorectal Cancer Prevention

Disclaimer: The information provided requires further research to confirm calcium's definite protective effect.

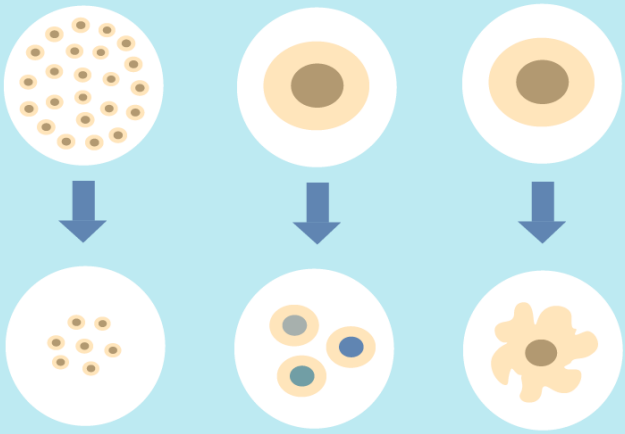
What Is Colorectal Cancer?



Our intestines are made of cells. Colorectal Cancer occurs when there is an uncontrolled growth of those cells.

How Does Calcium Lower Cancer Risk?

Reduces Cell Growth	Promotes Cell Diversity	Increases Cell Death

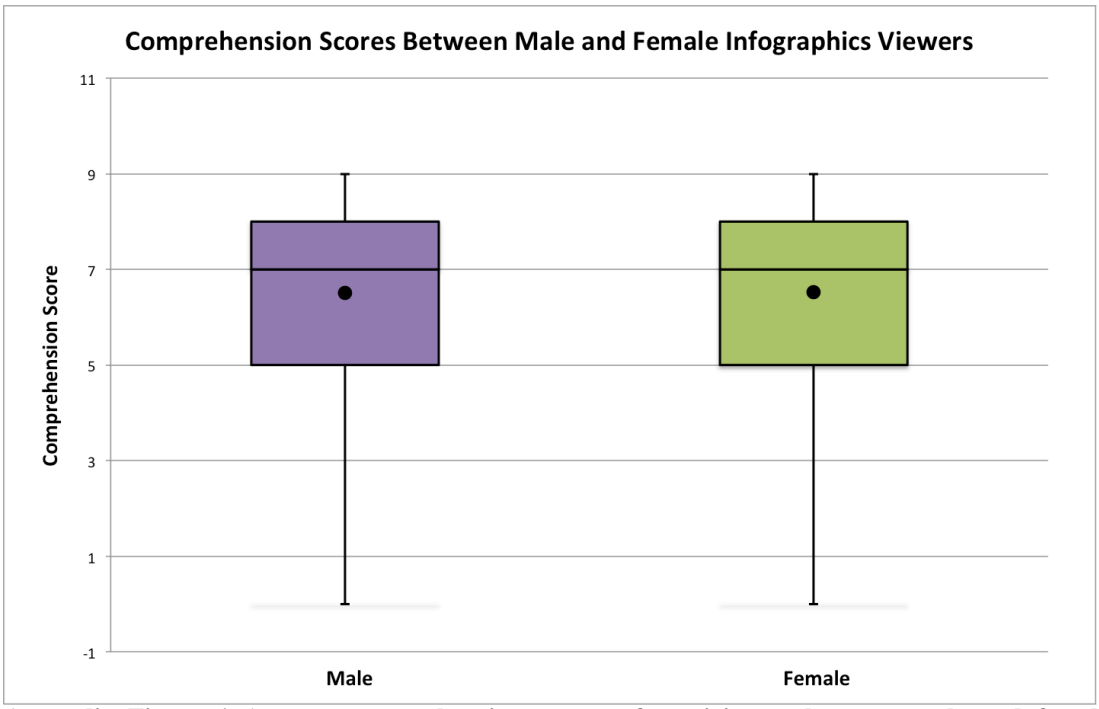


Cell division occurs at a lower controlled rate	Specialised cells are made to ensure normal body function	Regular cell death of non-healthy and unnessary cells

Calcium Rich Foods

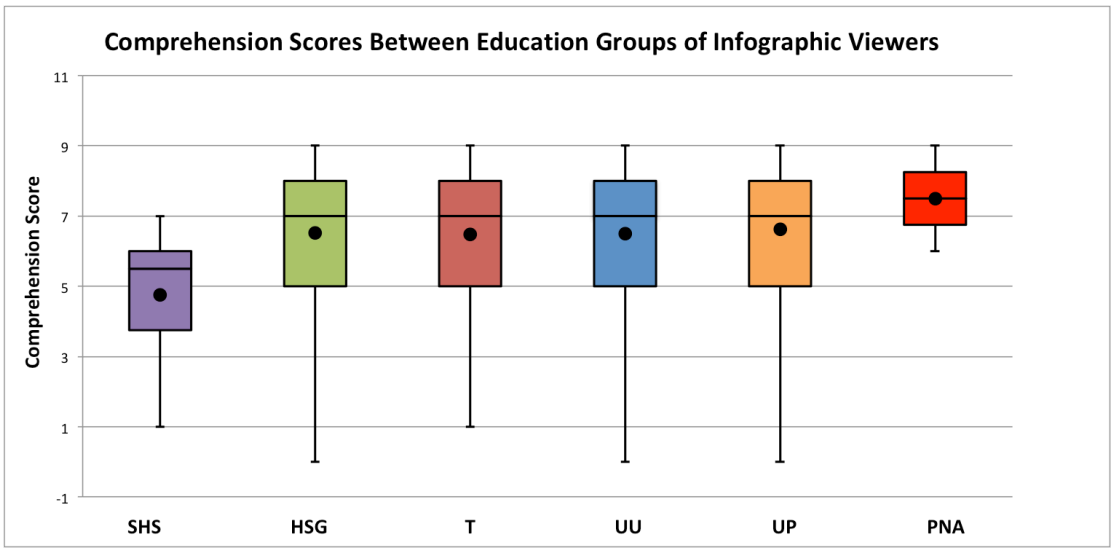
Milk | Yoghurt | Broccoli | Almonds

Appendix E: Gender and Age Data



Appendix Figure 1 Average comprehension scores of participants between male and female infographic viewers. Dataset included scores from each animated and static viewers. N (Male) = 508, N (Female) = 503, Levene's Test significance value = 0.349, p-value = 0.848. Dataset underwent Independent Samples T-tests. The figure shows one representative experiment.

Standard Deviation		Mean		95% Confidence Interval	
Male	Female	Male	Female	Lower	Upper
2.11	2.02	6.50	6.53	-0.28	0.23



Appendix Figure 2 Average comprehension scores of participants between education groups. Dataset included comprehension scores from each animated and static infographic viewers. Some High School (SHS): N = 8, High School Graduate (HSG): N = 158, Trade/Technical/Vocational Training (T): N = 98, University Undergraduate (UU): N = 507, University Postgraduate (UP): N = 236, Prefer Not to Answer (PNA): N = 4. Levene's Test significance value = 0.257, Analysis of Variance

(ANOVA) p-value = 0.182. Dataset underwent ANOVA statistical test. The figure shows one representative experiment.

	Standard Deviation	Mean	95% Confidence Interval	
Some High School	1.98	4.75	3.09	6.41
High School Graduate	1.87	6.53	6.23	6.82
Trade/Technical/Vocational Training	2.08	6.48	6.06	6.9
University Undergraduate	2.11	6.49	6.31	6.67
University Postgraduate	2.1	6.63	6.36	6.9
Prefer Not to Answer	1.29	7.5	5.45	9.55