“Are food choices and dietary quality affected by different types of dental prostheses worn by edentate elders?”

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Dedication

I dedicate this thesis to Prophet Mohammad, my role model and my ultimate teacher in this life. It is also dedicated to my parents for their utmost love, care, education and support. Finally, it is dedicated to my wife, Nour, and my children, Leen, Jana, and Jameel, for all the happiness and joy they bring to my life.

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Abstract

Mandibular implant-retained overdentures have been reported to improve chewing ability, as well as increase satisfaction and Oral Health Quality of Life for edentate individuals. However, there is still no enough evidence that this type of treatment improves the overall food choices and dietary quality. Moreover, there is no clear classification of the kinds of food that are considered challenging for edentate denture-wearing people to eat. Therefore, the aim of this randomised clinical study was to determine whether treatment with mandibular implant-retained overdentures is different than with conventional dentures regarding food choices. Selected foods were categorized into three groups, according to the reason why each is challenging. A total of 255 edentate individuals ≥ 65 yrs of both genders were randomly divided into two groups and assigned to receive a maxillary CD and either a mandibular IOD or a CD. One year following prosthesis delivery, 217 participants (CD =114, IOD = 103) reported the food and quantities they consumed to a registered dietician through a standard 24-hour dietary recall method. The mean and median values of total selected foods and each food category individually consumed by both groups were calculated and compared statistically. No significant between-group differences were found ($p > 0.05$). Despite the many advantages of IODs, this randomised study detected no evidence of dietary advantages for edentate elders wearing two-implant mandibular overdentures over those wearing conventional complete dentures in relation to their dietary intake at one year following prosthesis delivery.

Résumé

Les prothèses mandibulaires à rétention implantaire sont reconnues pour améliorer la mastication, et augmenter la satisfaction et la qualité de vie relative à la santé bucco-dentaire des personnes édentées. Cependant, Il existe peu de littérature scientifique sur les effets globaux de ce type de traitement sur la qualité et le choix alimentaire. De plus, une classification rigoureuse du type d'aliments que les porteurs de prothèse ont de la difficulté à consommer n'est pas disponible présentement. Par conséquent, l'objectif de cette étude clinique randomisée était de déterminer si la prothèse mandibulaire à rétention implantaire (PMRI) procurerait un avantage quant à la qualité et au choix alimentaire comparée à la prothèse conventionnelle (PC).

Deux cent cinquante-cinq hommes et femmes édentées, âgées de 65 ans ou plus, ont été répartis aléatoirement en deux groupes devant recevoir soit une PC maxillaire et une PMRI mandibulaire, soit une PC maxillaire et une PC mandibulaire. Un an après la réhabilitation prothétique, 217 participants (PC = 114, PMRI = 103) ont fournis des renseignements sur le type et la quantité d'aliments consommés à une diététicienne grâce à la standard méthode de rappel alimentaire de 24 heures. Nous avons classés les aliments en trois groupes selon la difficulté éprouvait par les porteurs de prothèse à les consommer. Les valeurs moyennes et médianes de quantité d'aliments consommés pour chacun des 3 groupes ainsi que celles de quantité totale d'aliments consommés ont été comparées entre les participants ayant reçu le PC et ceux ayant reçu la PMRI. Nous résultats n'ont montré aucune différence significative entre les 2 types de prothèse ($p > 0,05$). Malgré les nombreux avantages de la PMRI, un an après la réhabilitation prothétique, notre étude randomisée n'a révélé aucune évidence suggérant que les aînés portant une prothèse maxillaire

conventionnelle et une mandibulaire retenue par deux implants auraient des avantages alimentaires comparés à ceux portant des prothèses maxillaire et mandibulaire conventionnelles.

CHAPTER 1: Introduction and Literature Review.

1.1 Aging and Edentulism in Canada.

The population in Canada is aging; however, it has one of the lowest percentages of elderly people among the OECD countries [1]. As of 2009, over 4.5 million people aged 65+ accounted for approximately 14% of the population [1]; this is lower than the percentage of seniors ≥65 years) in the United Kingdom (16%), France (16.6%), and Germany (20.2%). One the other hand, the proportion of seniors is expected to rise rapidly because, the life expectancy of people at age 65 is increasing [1]. In 1985, a Canadian senior could expect to live an additional 17 years, but by 2006 that expectation had increased to 20 years. The number of Canadian centenarians may well reach over 17,000 by 2030 [1]

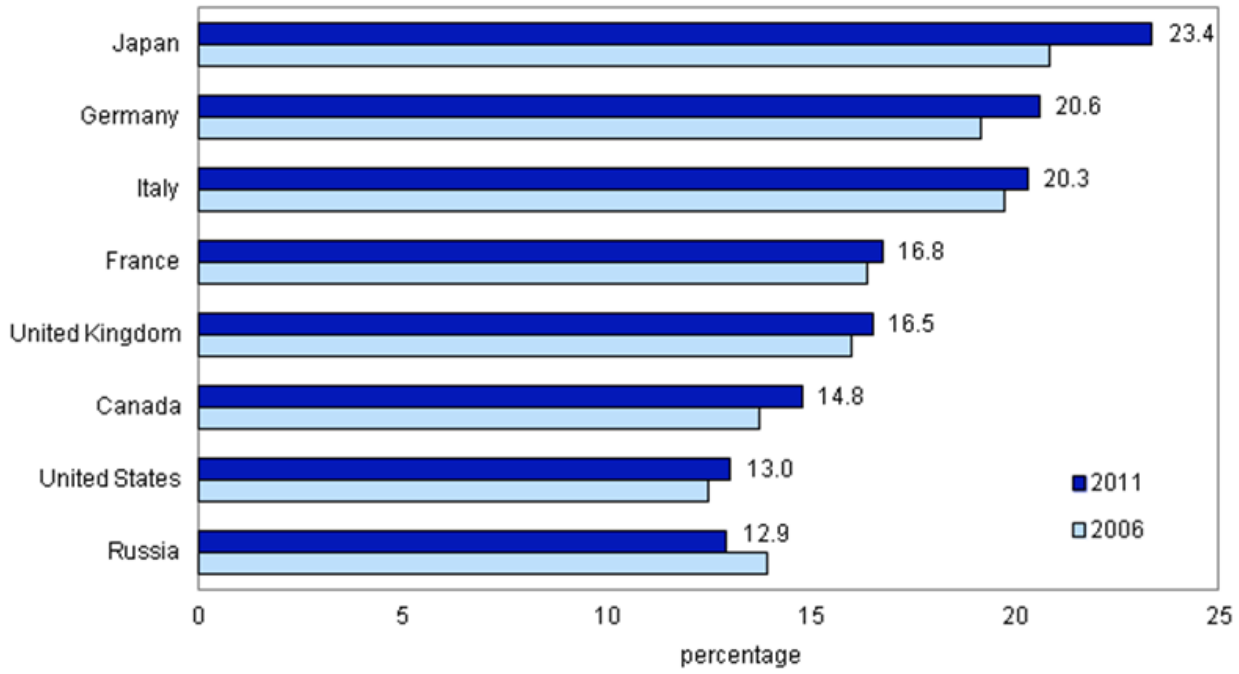

Figure1.1 Proportion (in percentage) of the population aged 65 and over, G8 countries, 2006 and 2011.
Sources: *Statistics Canada, censuses of population, 2006 and 2011; U.S. Census Bureau, 2006 and 2010; National Institute of Statistics (Italy), 2006 and 2011; National Institute of Statistics and Economic Studies (France), 2006 and 2011; Statistics Bureau of Japan, 2006 and 2011; Russian Federation Federal State Statistics Service, 2006 and 2010; and Human Mortality Database for Germany, 2006 and 2010, and for United Kingdom, 2006 and 2010.*

The Maritime Provinces have the largest proportion of seniors, at ≥15% of the total population, while Alberta has the lowest at 10% [1].

According to the Canadian Community Health Survey (CCHS) and the Health Promotion Service, the prevalence of complete tooth loss has declined over the last 2 decades [2]. In 1990, 48% of edentate individuals were ≥65 years, declining to 30% in 2003 [2]. Unsurprisingly, this decrease can be attributed to pervasive water fluoridation and improved dental care access [3]. In addition, there has been a rise in gross income, an increase in the dentist-to-population ratio, and growth of dental insurance coverage [4-6]. There is a clear difference in the prevalence of edentulism in males (26%) and females (33%) ≥65 years [2]. Quebec has the highest prevalence of edentulism (14%), while the Northwest Territories has the lowest (5%). Several factors are associated with this high rate, such as: poorer access to fluoridated water in Quebec and a higher rate of smoking amongst Quebec residents than in other Canadian provinces [7, 8].

Several studies show a significant correlation between total income and tooth loss. The proportion of edentate Canadians with a low income is 18%, compared to 3% in the highest income groups [2].

1.2 The Effect of Tooth Loss in the Elderly Population.

It is well known that the functional perfection of the of the oral cavity is essential for proper nutrition, food selection, and enjoyment that is derived from perceptions of taste, smell, structure, temperature, and other factors[9]. There are several factors that contribute to tooth loss; these include predisposition, race, diet, hormonal status, general health condition and lack of access to oral hygiene techniques and dental clinics [10]. Periodontal diseases, rather than dental caries, appear to be more responsible for tooth loss in elderly people. However, other studies

have shown a strong correlation between dental caries and loss of teeth in elders [11-13]. In one study, it was reported that race and socioeconomic status (SES) are important factors associated with tooth loss[14]. SES has been reported to be associated with both complete tooth loss [15] and with the level of loosing teeth among the dentate population [16].

Tooth loss has several negative effects, starting with emotional impact and declines in masticatory ability and healthy dietary intake. It has been well-recognised that people with tooth loss have a greater tendency toward social avoidance and having negative personality characteristics [17]. Even negligible facial abnormalities may lead to social stigma. Tooth loss is also responsible for stress [18]. Furthermore, Bergendal has recognized that complete tooth loss is a critical life event [19]. Emotional effects have recently been studied in detail. A qualitative study showed a broad range of emotional reactions to tooth loss that include disinheritance, lack of self confidence, worry about appearance; concealing tooth loss, behaviour change, early aging and the request for prosthodontic confidentiality. Moreover, tooth loss has been expressed as a feeling similar to losing a part of one's own self [20]. Thus, the emotional impact of tooth loss on people's lives should not be neglected or underestimated [21]. On the clinical side, an increase in tooth loss is recognized to decrease occlusal force [22]. There is also a change in function that can cause problems with chewing, swallowing and food selection [23]. Perhaps for this reason, it has been shown that edentulous populations have poorer nutritional health than dentate populations [24].

Malnutrition in geriatric populations has been reported to increase morbidity and mortality [23]; and therefore, failure to maintain a balanced diet may lead to an increased rate of physical disability and mortality in edentulous people without prostheses. Some studies have reported that

mortality is increased in elderly people with fewer teeth [25, 26]. Not replacing missing teeth appears to significantly increase mortality [27].

One study has reported that tooth loss is a risk factor for Alzheimer's disease[28]. The results of an animal experiment suggest that the loss of molar teeth is responsible for disability in spatial memory and the cholinergic system, which may suggest that tooth loss is a risk factor for dementia[29].

Numerous studies have linked edentulism with various medical conditions. Significant differences have been reported between edentate and dentate individuals in the prevalence of atherosclerotic vascular disease, heart failure, ischemic heart disease and joint diseases [30]. In addition, it was reported that deterioration of general health and, subsequently, death may occur swiftly in individuals with the fewest teeth [27].

Tooth loss has a direct effect on masticatory muscle function [31-33]. According to several studies, the presence of tempromandibular joint dysfunction (TMD) is correlated with tooth loss [34, 35]. The lost of posterior teeth increases the risk of osteoarthrosis of the Tempro-Mandibular-Joint (TMJ) [36]. Histologically, after four weeks of removing molars in young rats, there was thinning of condylar cartilage and changes in the neck of the condyle [37]. Radiographically, there was a reduction in condylar growth by about 7% [38]. Severe tooth loss may lead to histomorphological, pathological, and pathophysiological changes in the articular structures of the TMJ, and it was reported that these changes worsen with increasing age [37].

Loss of teeth has an essential influence on oral health related quality of life, independent from the impact of age. That adverse impact increases more rapidly corresponding to the increase in missing teeth. A complete or close to complete natural dentition has been linked with optimum

oral health related quality of life [39]. Tooth loss can affect general health by influencing the psychological dimensions of oral health-related quality of life. The World Health Organization has clearly defined 'health' as 'a state of well-being which is a broader definition than just an absence of the disease' [40].

Finally, tooth loss has been shown to be positively associated with some health-risk behaviours such as smoking and alcohol intoxication [41-47].

1.3 Conventional Methods in Treating Edentulism.

Maxillary and mandibular dentures have been used as the first choice of treatment for over a century, mostly due to the lack of alternative treatments [48]. For an appropriately selected patient, a complete denture may be a safe, predictable, and affordable treatment to restore edentulism. However, there is a significant variation amongst individuals regarding their ability to adapt to conventional dentures [49, 50]. A strong relationship was reported between patient satisfaction and the amount of mandibular residual alveolar bone, as well as retention and stability of the mandibular denture and accuracy of reproduction of retruded jaw relationship. It has been suggested that the process of fabricating a denture plays an important role in patient satisfaction by influencing denture stability [51]. However, a more recent study has shown that the amount of residual bone in the mandible has no relation to patient satisfaction [52].

Several studies have reported that satisfaction is one of the most important factors for patients who wear complete dentures [53-56]. Since patients and clinicians do not usually rate an individual prosthesis in the same way, it is now accepted that the patient's perspective is the most valid [57, 58].

Edentulism is a chronic condition [59], just like the loss of any other body part(s). Devices (prostheses) are provided to people with missing body parts to improve their function and life quality. A denture is one of those types of devices. Since it is the patient who must use the device, should it not be the patient who is the most relevant judge of it?

Furthermore, studies have shown a correlation between high neuroticism and patient satisfaction; therefore, neurotic patients are less satisfied with their conventional dentures [60]. In another study, there was evidence to support the level of eduction in patients with complete dentures. However, use of complete dentures was not influenced by personality traits. [60, 61].

While maxillary complete dentures are considered to be an appropriate form of treatment for the upper edentulism, the mandibular denture is usually a source of discomfort for most denture wearers because it lacks adequate retention and support due to movement of the tongue and lip/cheek muscles, as well as the small tissue bearing area [62, 63]. When mandibular and maxillary dentures are compared, it has been shown that stability and comfort are greater for the maxillary denture than for the mandibular [64]. It has been suggested that the stability of a prosthesis may be a key factor for its acceptance [65]. Anterior bone height of the mandible is resorbed approximately four times faster than that of the maxillary bone [66, 67]. The continuous resorption of the mandibular alveolar ridge reduces the stability and satisfaction with the mandibular denture [68]. Mandibular edentulism and denture instability are associated with a wide spectrum of functional impairments that range from decreased masticatory function, to phonetic problems and, sometimes, restriction of social activities [57, 69].

Several methods have been applied to enhance mandibular denture retention. Denture adhesives are widely used as an appropriate method to enhance retention and stability of the conventional

dentures [70-79]. It has been reported that there are more benefits of using denture adhesives for existing dentures than there are for newly fabricated dentures [80]. In one study, all subjects reported that retention of their dentures was improved when using an adhesive paste [78]. In another study, five different denture adhesives were compared, and the benefit of using adhesive pastes was confirmed [81].

Denture stability can be further enhanced by application of the neutral zone technique to establish balanced muscular control over the denture [82]. It is an alternative approach for fabricating mandibular complete dentures, and it is more efficient when there is a highly atrophic ridge and history of denture instability. [82].

Other techniques for denture construction may improve denture success. For example, laboratory and clinical remount procedures and occlusal corrections decrease the number of follow-up visits, and therefore, maximize patient comfort and satisfaction [83]. However, two studies have recently shown that these complex techniques do not provide any additional improvement in denture success [84, 85]

Although contemporary techniques have improved over the years to enhance retention and stability of mandibular dentures, these devices are still inadequate for many patients.

1.4 Association of Denture Use with Oral and Systemic Health.

Denture wearers often have a high prevalence of various oral mucosal conditions. It has been reported that problems associated with denture wearing include angular cheilitis, denture stomatitis and traumatic ulcers [86]. One of the most common mucosal lesions is denture stomatitis [87]. It has been reported that the prevalence of stomatitis among complete denture wearers varies between 11% and 67% [87]. The etiology of this condition has been believed to

be due to yeast colonization of poorly fitting surfaces of the denture[87]. However, it has been recently reported that there is no significant difference between antifungals and other treatment alternatives in treating denture stomatitis [88].

It also may be associated with allergic reaction to the material of the denture or symptom of systemic disease[87]. Denture stomatitis is associated with denture hygiene [89, 90], continuous usage of the denture during the night [90], use of faulty dentures [91], and consumption of tobacco and alcohol [92]. It has been reported that the prevalence of denture stomatitis is increased with low level of education and long gaps between dental visits [92]. There are other oral lesions associated with wearing dentures such as papillary hyperplasia and traumatic ulcers, and theses lesions are commonly seen in 4 to 26% of older dentures [86, 89]. Both lesions were reported to be seen more frequently among patients who wear complete dentures than in removable partial denture wearers [93]. Nocturnal use of the denture diminishes the positive effect of saliva and the protective biological features of the keratinized mucosa [94, 95]. The oral biofilm of denture wearers has been studied, and it was reported that the bacterial species detected in denture wearers suggested that patients may be at some risk for systemic diseases possibly associated with these pathogens [96]. Dentures provide an incubator for bacteria associated with different kinds of infections such as bacaterial endocarditis, pneumonia, chronic obstructive pulmonary disease, and gastrointestinal infection [97]. *Candida Albicans* species, which are often seen in denture plaque, are responsible for oral mucosal inflammation, especially stomatitis [98].

Brunello and Mandikos observed that denture design faults are associated with the condition of the patient's mucosa [99]. Approximately, one-third of the patients with complete dentures are reported to have mucosal irritation. The most prevalent problems reported were: denture bases

under extension, and incorrect jaw irritation. Less frequent problems were incorrect occlusal vertical dimension and inadequate posterior palatal seal [99].

1.5 Dietary Intake in Edentulous Individuals with Complete Dentures.

Although the notion that the number and state of the teeth affect food choice, diet, and nutrition has been accepted, very little data support this hypothesis [100-102]. A reduced number of teeth causes dietary restrictions through difficulty in chewing and some prostheses cover taste buds, leading to a decreased sense of taste, thereby compromising nutritional status [103, 104]. It was also reported that individuals who can't masticate comfortably usually avoid rich-fibre foods such as bread, fruit, and vegetables and, therefore, lack some essential nutrients in their food intake [105]. In the elderly population, approximately 20% reported that oral conditions like tooth loss prevented them from chewing food they like, and 15% took longer to complete their meals; of these, they did not enjoy food as usual [106]. Since tooth loss is common in elderly people, there is evidence that edentulism may alter food choice and, therefore, decrease the total intake of some key nutrients such as iron and fibre [107-110]. It has been reported that edentate populations consume fewer vegetables and fruits, less fibre and carotene, and more cholesterol, saturated fats, and calories than their dentate counterparts [24, 111, 112]. Other studies have reported the reduction in non-starch polysaccharide (dietary fibre) intake by edentate elderly people [24, 108, 113]. The intake of this kind of polysaccharides was higher in people with more teeth, especially the number of occluding pairs of posterior teeth (POPs) [114, 115]. Elderly populations without teeth consumed less energy-rich food and fewer proteins, intrinsic and milk sugars, calcium, non-heme iron niacin, and vitamin C than dentate people [116]. Individuals with more than 20 teeth consumed more nutrients than those with fewer teeth and, therefore, had a

superior dietary and nutritional intake. Increases in food and vegetable consumption are directly proportional to the number of teeth and the POPs.

Levels of ascorbate in the plasma of elderly populations have been shown to be significantly related to the number of occluding pairs of teeth [116]. Only twenty percent of edentate people reported that they consumed food rich in vitamin C, especially raw fruits and vegetables, with some or no difficulty in chewing [112]. Vegetables and fruits are usually subjected to different kinds of processing (cooking, peeling, slicing etc...) by people with fewer teeth, so they may lose some of the vitamin C value in their content [112].

It was reported that the total intake of a variety of nutrients, such as vitamin C, vitamin E, calcium, protein, fibre, non-heme iron, thiamine, riboflavin, niacin, pantothenic acid, and intrinsic and milk sugars, was significantly higher in dentate than in edentulous people, [113]

In two large-scale studies that focused on populations over the age of 65, it was reported that edentulism is a significant risk factor in lower intakes of nutrient-rich foods and, therefore, lower levels of nutrients in the bloodstream [112, 117].

In poorly nourished individuals, the oral tissues can become friable and, therefore, incapable of resisting trauma from denture movement [118]. As a result, individuals tend to consume softer, more highly flavoured foods, that have lower nutritional value. There is evidence that improving the quality of conventional complete dentures does not alter dietary selection in edentulous individuals [119, 120].

It was also reported in several studies that the percentage of total calories increase in edentulous people were obtained from fat and increased amount of consumed cholesterol [24, 107, 121, 122].

Edentate populations that don't have comfortable, stable prostheses are predisposed to poor nutrition and may be at a great risk for a variety of diseases. Low consumption of vitamin A may be a risk factor for various forms of cancer, heart diseases, and rheumatoid arthritis [123]. Vitamin E deficiency is associated with cancers, heart disease, and Parkinson's disease [123]. Low vitamin C consumption leads to disturbances in immune system function and increased risk of cardiovascular disease, myocardial infarction, and hypertension [123]. Thiamin deficiency is responsible for nausea, constipation, appetite loss, and weight loss [123]. Riboflavin insufficiency can increase the tendency toward cataracts and arthritis, while low levels of pantothenic acid may affect the function of the nervous system and wound-healing capabilities [123]. In addition, increased intake of fat and cholesterol are associated with obesity and diabetes mellitus, atherosclerosis, heart disease, stroke, and hypertension [123, 124].

1.6 Implant Overdentures as an Alternative Prosthetic Device.

As described earlier, mandibular alveolar bone volume continuously decreases following tooth extraction [66, 125]. This bone resorption progresses more rapidly in the mandible than in the maxilla and, therefore, makes well-fitting mandibular denture construction more difficult [68] .

Although the term "osseointegration" was first coined in the early 1950s when Swedish professor Branemark discovered that bone tissue could be integrated with titanium implants; osseointegrated dental implants were not well accepted in Dentistry until the early 1980s, when they were used as abutments to support intra oral prostheses [126, 127]. Since that time, the long-term success of two-implant retained overdentures as a method to stabilize complete mandibular dentures has been well reported [128-135]. Oral implant placement may prevent or at least reduce the continued resorption of bone [136].

The role of the implants in improving the support, stabilization, and retention of complete mandibular overdentures has been scientifically supported since the mid-1980s, and several studies and clinical trials have shown the feasibility, safety, superior functionality, and satisfaction with implant- retained and tissue-supported mandibular overdentures when compared with new conventional complete dentures [54, 69, 137-149]. A prospective study in which evaluate a treatment with implants in edentulous mandible over 20 years reported excellent results [133].

One of the most important factors considered when designing studies comparing conventional denture treatment and implant overdenture treatment is cost, as this factor is a top priority when selecting treatment type for individual patients [150, 151]. Although implant-retained overdentures are more expensive than conventional complete dentures, they are still less costly than fixed mandibular prostheses supported by implants due to the increased number of implants used and rising prosthodontic complexity required for a fixed implant-supported prosthesis. In other words, implant-retained overdentures are a more cost-effective treatment for edentulous patients than fixed prosthodontic treatment [152-155]. Furthermore, no significant difference was found between implant-retained overdentures and fixed implant-supported prostheses when compared and rated by patients for function and satisfaction [156]. Some elderly people who were accustomed to wearing conventional dentures prefer removable overdentures over fixed implant-supported prostheses [156].

In 2002, the McGill Consensus Conference concluded that conventional complete dentures is no longer the most appropriate first-choice prosthodontic treatment for edentulous mandible since evidence for the superiority of implant overdentures was strong [48]. The consensus declared that the first choice of care for the edentulous mandible should be a minimum of two implant-

retained overdentures [48]. It also suggested that treatment of the edentulous mandible using implant-retained mandibular overdenture should be the "standard of care" [48]. Another publication from a literature review concluded that [157]:

1) Retention and stability problems have negative impacts on treatment results of conventional mandibular dentures.
2) The rate of dental implant success in the anterior mandibular segment is excellent.
3) Implant-retained mandibular overdentures offer many benefits compared to conventional mandibular denture treatment.
4) Implants inserted in the anterior mandible can slow the process of physiological bone resorption.
5) There is a need for routine recall and follow-up evaluation for inserted implants especially during the first year of treatment.
6) There is a significant increase in patient satisfaction with mandibular implant overdenture treatment compared to conventional denture treatment.

Despite the relative disadvantages of implant-retained overdentures regarding cost, surgical approach and potential maladaptation to a complex intraoral appliance, this treatment option includes several biological advantages, such as a decrease in bone resorption, considerable improvement in masticatory function [158] and avoidance of food impaction [159]. It has been reported that pain, perceptions of poor chewing function and speech, and dissatisfaction with appearance are important factors that motivate edentulous individuals to consider oral implants in their treatment plan.

A long-term study (10 -19 years) of implant-retained overdentures reported positive outcomes [149]. The cumulative survival rates for both the prostheses and implants were over 90%, and relining was not required until up to 4 years, on average [149]. The majority of similar studies done on implant-retained overdentures reported high implant survival rates and low biological complications [54, 160-163].

Furthermore, several studies have reported that the Oral Health Quality of Life was significantly higher in individuals with implant-retained overdentures than those with conventional dentures [57, 164, 165].

1.7 Dietary Quality and Nutrition in Elderly People Wearing Prostheses.

Restriction of food selection has been shown to influence oral health and nutritional state among edentulous individuals[166]. Data analysis from the National Health and Nutrition Examination Survey (1988 to 1994) revealed that people with less than 28 natural teeth have significantly lower intake of food such as carrots, salads, and daily grams of dietary fibre [167]. When people cannot chew easily, their food choice behaviours change in three different ways. First, individuals avoid hard natural food by eliminating crunchy food such as raw vegetables and fresh fruits[24, 105, 168], tough foods such as steaks[169-171], and dry food such as breads[170-172]. Second, people choose to consume processed food that contains large quantities of carbohydrates, fats, and cholesterol rather than natural food[103, 166] and, in addition to that, they over-cook food to soften it, which degrades essential nutrients and possibly produces trans-fatty acids, thereby reducing the nutritional value of the food[173, 174]. It has been reported that saturated fatty acids are a risk factor in atherosclerosis, and increasing the intake of cholesterol and fatty acids raises the risk of cardiovascular diseases[175-178]. In addition, a fatty diet is

related to obesity, which increases the risk of hypertension [179], cardiovascular diseases, and noninsulin dependent diabetes [180, 181]. Third, some fruits , such as tomatoes, grapes, raspberries, and strawberries are also avoided because their seeds can slide under the dentures; lack of these may result in a reduced blood level of pro-vitamins (B-carotene), Vitamins A, B1, B2, B3, B5, B6, B12, C, and E, proteins (albumin), and minerals (Ca, Fe, and K) [24, 47, 105, 113, 117, 121, 122, 167, 170, 182-188].

Epidemiologic studies in different countries have reported that eating vegetables and fruits can reduce the prevalence of cancer in several body sites [189-197]. One review study has reported that there is a strong relationship between food intake and cancer in the lung, colon, cervix, esophagus, mouth, bladder, pancreas, stomach, or ovary, and that consumption of fruits and vegetables plays a protective role[193]. Many anti-carcinogenic agents have been detected in vegetables and fruits [196]. The mechanism of action of these agents includes inhibition of nitrosamine formation, antioxidant effects, provision of substrates for formation of antineoplastic agents, and dilution of binding of carcinogen [196].

The skin of raw vegetables and fruits are an essential source of fibre. Fibre facilitates gastrointestinal transit, reduces plasma cholesterol levels, lowers the glycemic response to meals that contain carbohydrates, and decreases the prevalence of colorectal cancer[198]. Moreover, it has been reported that a fibre-rich dietary is recommended for the prevention of Crohn's disease, hyperlipidemia, diabetes, diverticular disease, constipation, gallstones, and irritable bowel syndrome, and colonic cancer[199].

People may acquire poor dietary habits with tooth loss, poor occlusion, and other pathological conditions even with dental devices to improve oral function [200-202]. It has been reported that

individuals who wear complete dentures alter their dietary choices by avoiding food that requires efficient chewing [203]. Although these individuals should select a diet that is rich in vitamins, minerals, and dietary fibre from fresh fruits and vegetables, and reduce their consumption of food that is rich in fats and sugars, their prostheses do not provide them with the chewing capacity necessary to accomplish this. [204, 205].

Patient satisfaction with dental prostheses is associated with masticatory capacity, chewing efficiency and understanding that dental treatment affects food choices [206]. Food modifications such as steaming, chopping, and liquefying food are common behavioural adaptations when there is oral discomfort [206]. Performing a dietary assessment immediately after placement of the prosthesis and after six months following placement of the prosthesis could provide oral health care providers a chance to educate and provide recommendations to patients to assist them in optimizing their dietary choices [207]. One systematic review has reported conflicting clinical trial outcomes for selected studies in which several types of removable prostheses and related dietary quality were compared [208]. In another systematic review of both complete and partial removable prostheses it was found that the occlusal scheme of the prosthetic design does not affect diet[209]. Implant-retained overdentures improve a person's reported chewing ability more than complete dentures; however, this was not associated with improvement in dietary quality [119, 210].

Therefore, we wished to determine whether edentate people wearing mandibular implant-retained overdentures would eat a healthier diet than those wearing conventional complete dentures.

1.8 Specific Aims and Objectives.

I. To determine whether a new treatment changes food choices.

II. To determine the impact of using implant-retained overdentures on eating food with seeds and small particles, and leaves.

III. To determine the impact of using implant-retained overdentures on eating hard foods.

IV. To determine the impact of using implant-retained overdentures on eating sticky food.

CHAPTER 2: Thesis Objectives and Outline.

2.1 Hypotheses.

2.1.1 Primary Hypothesis.

People change their food choices and dietary quality when they receive new conventional dentures and mandibular overdentures.

2.1.2 Secondary Hypotheses.

1. People wearing implant-retained overdentures eat food with seeds, small particles and leaves more often than people wearing conventional complete dentures.
2. People with implant-retained overdentures eat hard food more often than people with conventional complete dentures.
3. People with implant-retained overdentures eat sticky food more often than people with conventional complete dentures.

CHAPTER 3: Materials and Methods.

This study is a secondary analysis of a randomized controlled study in which primary analysis shows no significant difference in the nutritional state of elderly edentate people at 6 and 12 months post treatment between the group that was treated with implant-retained overdentures and the other group that was treated with conventional complete dentures.

As mentioned earlier, this is a randomised controlled parallel trial. It compared the impact of two types of mandibular prosthetic treatment (conventional denture and implant-retained denture) in edentulous elders living in Montreal Quebec, Canada. Neither the subjects nor the treating clinicians were blinded to treatment allocation. However, all data were gathered and entered by nurses and dieticians who were blind to treatment allocation.

3.1 Trial Design.

There were two groups in this trial:

- **Control: Maxillary and mandibular conventional dentures.**

  All individuals in this group received new conventional dentures for both the maxilla and mandible.

- **Experimental: Maxillary conventional denture and a 2 implant-retained ovedenture with ball attachments for the mandible.**

The study was conducted in Royal Victoria Hospital (RVH) at the clinical investigation unit. Using a standard protocol, individuals in this group received two trans-mucosal titanium implants (ITI, Staumann- 048.242.243, Waldenburg, Switzerlend) in the inter-canine region of the anterior mandible. After a healing period of 3 months, the participants received maxillary conventional dentures and mandibular implant-retained overdentures with ball attachments.

3.2 Selection Criteria.

Advertisements were placed in the local French and English news for individuals who are willing to participate in the trial and in a monthly periodical for retired people as well. Individuals who were interested in participating were contacted and the study was fully described. Research assistants were to determine whether each potential candidate meets the demographic inclusion criteria, and then, invite him/her to an information session, in which all aspects of the treatment and the study were explained using overheads and slides. In addition, all the information related to the study was provided in writing to each potential individual. The consent form was handed out and read to each group by the research assistant, who was able to answer all questions raised. Patients were then examined by the clinicians, and each patient who met the eligibility criteria and was willing to participate was invited to sign the consent form. Ethical approval was granted from the McGill University Institutional Review Board (IRB) (*International Clinical Trial Registration #ISRCTN24273915*). Treatment assignment was obtained by the research assistant from the randomization center. The treatment group was randomly assigned using a computer generated permuted block scheme. All patients received financial compensation (for the transportation and parking costs) to participate in the study.

3.3 Inclusion/Exclusion Criteria.

All potential subjects completed a medical history that includes general health, oral health, and any medication usage. In addition, Mini-Mental State Evaluation tested for impaired cognitive function [211], as memory must work perfectly to provide accurate 24-hour dietary recall information. The clinicians determined if there was any condition that may interfere with the surgical or prosthetic treatment such as availability of sufficient bone in the anterior mandible, presence of chronic mucositis or hyperplasia. All participants were given dietary advice at baseline, 6 months, and 12 months as a standard of care for this condition. Patients who have BMI less than 20 or above 32 kg/m² were excluded from the study because they may have conditions that would interfere with the interpretation of the data.

3.3.1 Inclusion Criteria.

- Male and female.

- Age 65 years and older.

- Completely edentulous for 5 years at least.

- Willing to replace existing conventional dentures.

- An adequate understanding of written and spoken English or French.

- Able to understand and respond to questionnaires used in the study.

- Willing and able to accept the protocol and to give informed consent.

3.3.2 Exclusion Criteria.

- Insufficient bone to place two implants in the anterior mandible.

- Any oral condition precludes immediate prosthetic treatment.

- Acute or chronic symptoms of temporomandibular disorders.

- History of radiation therapy to the orofacial region.

- Systemic or neurologic disease that contraindicates implant surgery.

- A neoplasm diagnosed within the last five years.

- A BMI that is less than 20 or more than 32 kg/m^2.

- Subjects with score of 24 or less on the Mini-Mental State Evaluation (who may be suspected of having impaired cognitive function).

- Any health condition that jeopardizes surgical treatment (alcoholism, etc.).

- Psychological or psychiatric condition that could influence diet and reaction to treatment.

For each individual participant, conventional denture treatment required approximately two months, while implant treatment took approximately five months. The treatment in this study was carried out over two and a half years. Data were gathered initially at baseline, then six month and twelve months following treatment. In this analysis, we analyzed the baseline and 12-month follow-up data as no significant change in the food consumed was found between the 6 and 12 month data collection periods.

Information on all types of food consumed by subjects was gathered using standardized and validated dietary recall methods [212]. The dietary intake evaluation included 24-hour recalls, weighed food records, dietary history, food diaries, and food frequency questionnaires. A 24-hour recall method was done three times for each recall occasion (Baseline and 12 months) as this method is used to describe participants' usual intake and to reduce variability between subjects. The first 24-hour recall was carried out by registered dieticians at baseline to assess portion size using food models. Two further recalls at 6 and 12 months were done over the telephone. All interviews were performed by dietitians trained using the Food Habits of Canadians Dietary Assessment Group, an FRSQ team headed by Dr Gray-Donald [213]. This Group carries out dietary survey and validation studies. (See Chapter 8 for 24-hour recall form sample).

3.4 Sample Size Selected and Completed the Study.

To insure sufficient power to assess the primary and secondary findings, sample size estimation was carried out, and it was found that 104 participants in each group would be adequate for a power of 95%, with a two-sided test at a 0.05 significance level for the primary outcome [210]. Therefore, a similar level of power was calculated for the secondary variables.

The following figures showed how many participants were selected for the study and how many successfully completed that study:

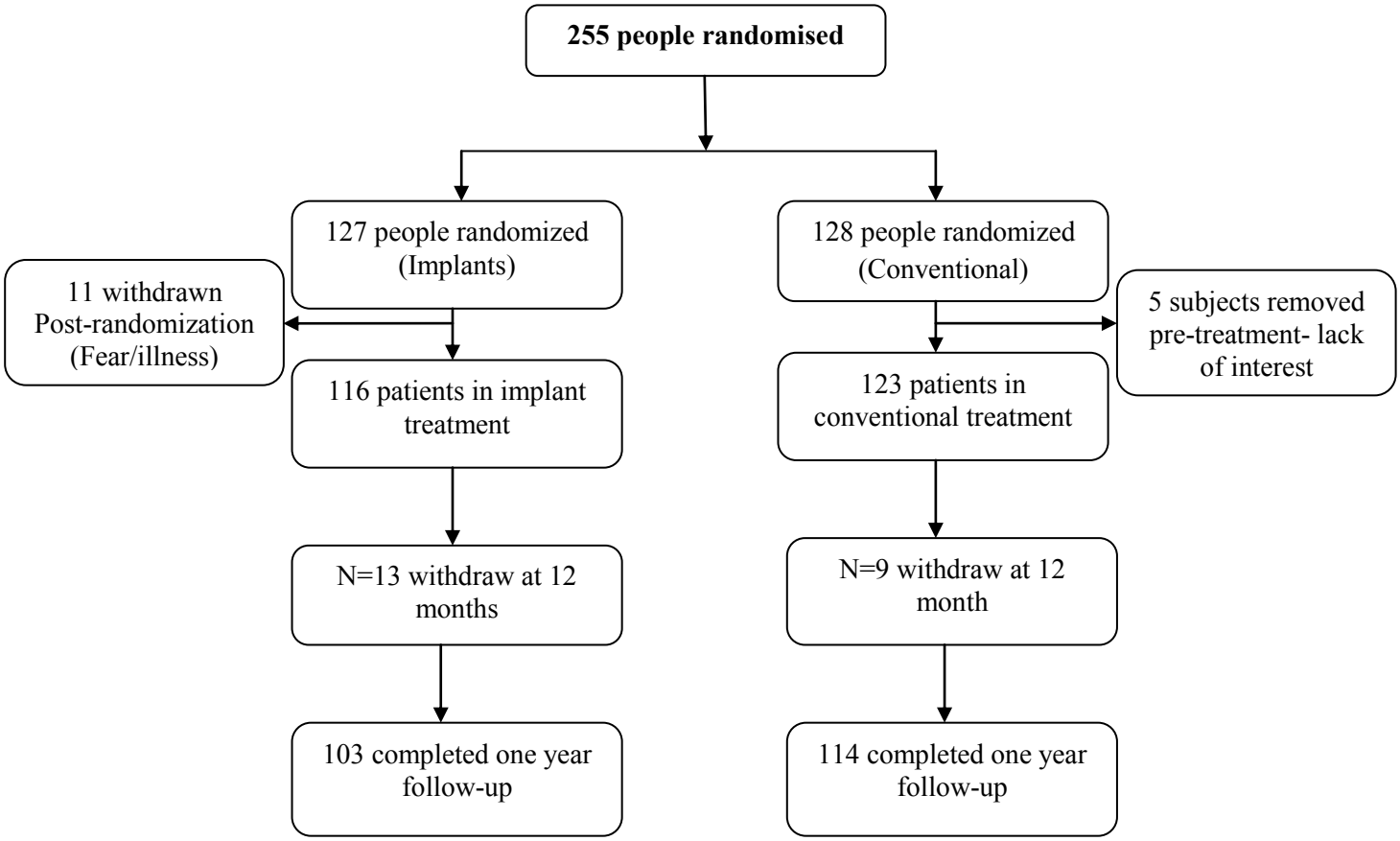

Figure3.1 *Flow chart of participants' enrolment in the study.*

3.5 Categorizing Food Choices.

In order for us to categorize the data on challenging foods consumed by each participant during the study period, we randomly selected seven edentate non-participants, aged 65 years and older who wore complete dentures for over five years, and we interviewed them over the telephone. They were asked to categorize foods that we had taken from the study data bank under one of the following categories: **food with seeds, small particles or leaves, hard food, or sticky food.**

These kinds of food have been shown to be the most challenging for individuals who are edentulous and wearing complete dentures [114, 117, 119, 206, 214-219]. Based on these interviews, the selected foods were categorized as follows:

Food with seeds, small particles or leaves **(Category I)**	Hard food **(Category II)**	Sticky food **(Category III)**
Nuts	Meat (Steak)	Soft bread
Tomatoes	Apples (whole)	Sticky candy
Pears	Toast (crusts)	Chewing gum
Figs	Celery	Dates
Grapes	Carrot	Dried fruits
Raspberries	Radish	
Blackberries	Raisin	
Seeds	Cabbage	
Crunchy peanut butter		
Cooked potato with skin		
Apples with skin		

Table 3.1 shows the categories of selected foods considered to be challenging for consumption by elderly edentate people.

Data were collected based on the 24-hour dietary recalls at the 12 month follow-up for both the conventional denture and implant overdenture groups. If any kind of food fell under more than one category; for example toasted bread with seeds (sesame), it was considered to be valid in both categories.

The frequency of the foods consumed was calculated at baseline and at 12-month recall. As the collected data has a skewed tendency and is not normally distributed, the medians were used to measure the central trend. A Mann-Whitney U test, which is a within-group non-parametric statistical test, was used to compare various independent variables. The data in each food category (I, II, III) at the 12-month time-point were compared for each of the treatment groups. The threshold for statistical significance was $P<0.05$.

CHAPTER 4: Study Results.

A total of 255 participants were randomized into two groups, the implant-retained overdenture group, IOD, (*n*= 127) and conventional complete denture group, CD, (*n*=128). The total cumulative loss to follow-up from the beginning of the study to the 12-month recall was reported to be 19% in the implant-retained group (*n*=24), and 14% (*n*=14) in the conventional denture group. Therefore, a total of 207 participants (*n*=114 CD, *n*= 103 IOD) were followed-up after 12-month post-treatment period and were included in this analysis. Reasons for withdrawal were varied and included fear of surgery, illness, or lack of interest. The ages of both groups were almost similar (CD mean = 69.7, SD 4.6; IOD mean = 70.5, SD= 5.0). Gender distribution in complete denture group was [males, *n*=57 (44.5%), females *n*=71 (55.5%)], while in the implant-retained denture group it was [males *n*=57 (44.9%), females *n*=70 (55.1%)] [Figure 4.1].

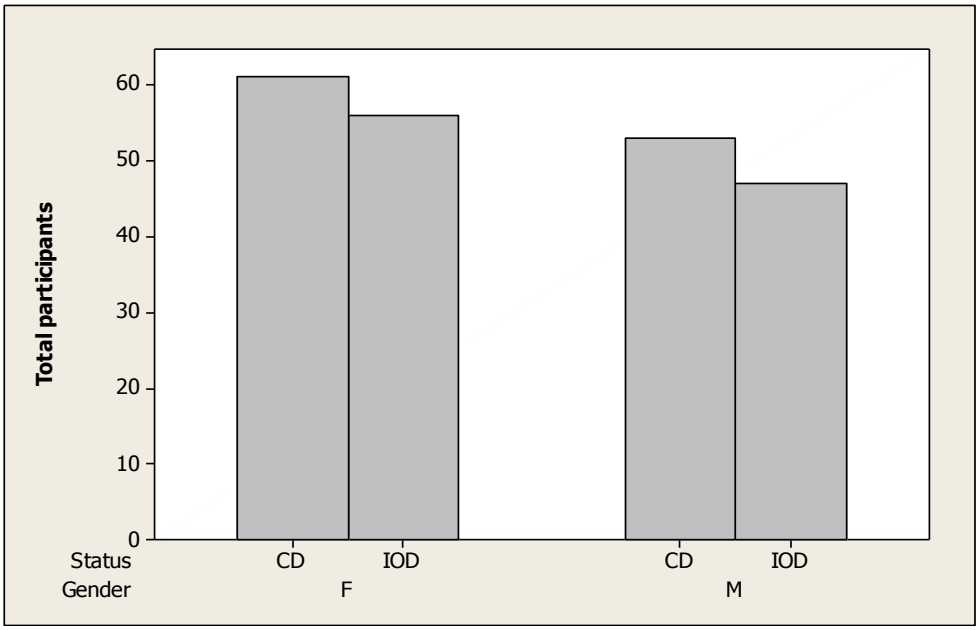

Figure 4.1 The total participants in the study with their distribution according to gender. F=Female. M=Male. CD=Complete denture group. IOD= Implant overdenture group. CD, n=114; IOD, n=103.

The proportion of food consumed among the three categories [food with seeds, small particles or leaves (category I), hard food (category II), and sticky food (category III)] at baseline was 13.3% in the implant-retained overdenture IOD group (Mean = 7.9 and SD= 3.6), and 13.7% in the conventional denture CD group (Mean= 8.3 and SD= 4.0). At the 12-month recall, the proportion of food consumption among the three groups was 13.9% in the implant-retained overdenture IOD group (Mean= 8.9 and SD= 4.4) and 13.3% in the conventional denture CD group (Mean= 8.7 and SD= 4.2) [Figure 4.2] and [Table 4.1]

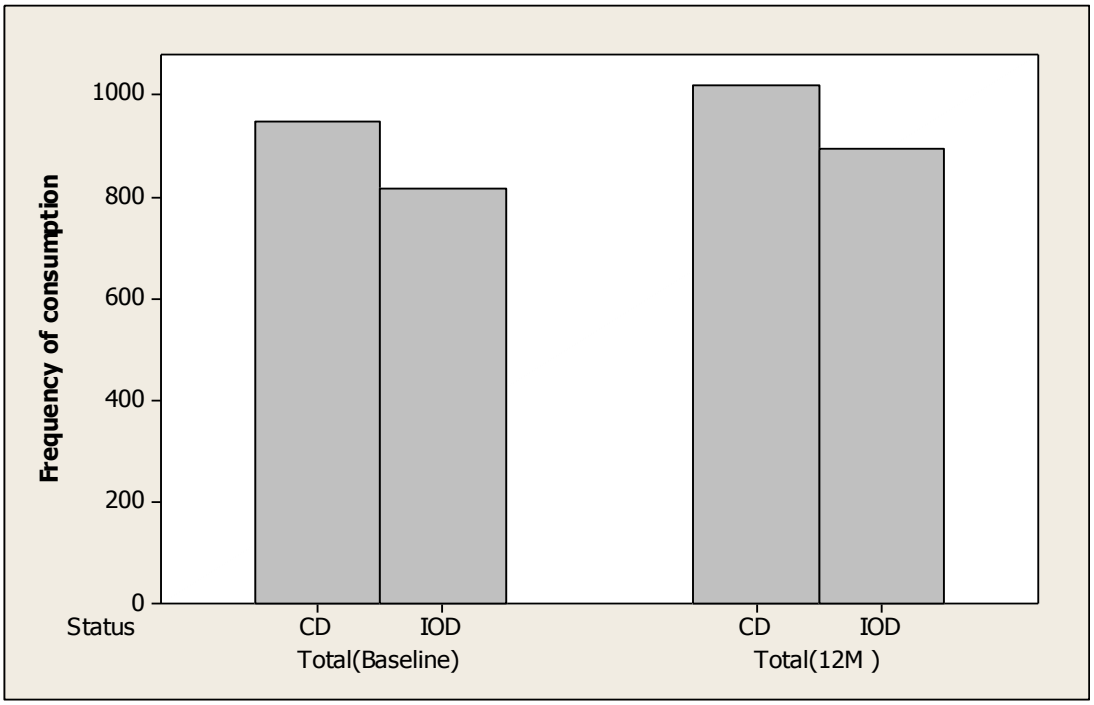

Figure 4.2 The total frequency (number of times) of consumption of all three food categories combined. CD=Complete denture group. IOD=Implant overdenture group. 12M= 12 months. CD, n=114. IOD,n=103.

		Baseline		12 Month Follow-up	
Variable	Group	Mean (STD)	Total (Proportion)	Mean (STD)	Total (Proportion)
Total Food from All Categories	CD	8.3 (4.0)	947/6912 (13.7%)	8.7 (4.2)	817/6642 (12.3%)
	IOD	7.9 (3.6)	1019/7662 (13.3%)	8.9 (4.4)	894/6431 (13.9%)
Food with Seed, particles, or Leaves (Category I)	CD	4.1 (3.0)	469/6912 (6.8%)	4.4 (3.0)	499/6642 (6.5%)
	IOD	3.5 (2.5)	366/7662 (5.5%)	4.0 (3.0)	409/6431 (6.4%)
Hard Food (Category II)	CD	3.9 (2.2)	445/6912 (6.4%)	4.3 (2.5)	486/6642 (6.3%)
	IOD	4.3 (2.1)	446/7662 (6.7%)	4.7 (2.3)	479/6431 (7.4%)
Sticky Food (Category III)	CD	0.3 (1.0)	33/6912 (0.4%)	0.3 (1.0)	5/6642 (0.1%)
	IOD	0.1 (0.3)	34/7662 (0.5%)	0.1 (0.3)	6/6431 (0.2%)

Table 4.1 Intergroup – Baseline and 12-month Average Means, standard deviations, total amount consumed of selected food categories and its proportion of the total food consumed by patients in that period for CD and IOD Groups.

The proportion of food from the category I (food with seeds, small particles or leaves) at baseline was 5.5% in the implant-retained overdenture IOD group (Mean=3.5 and SD= 2.5), and 6.8% in the conventional denture CD group (Mean=4.1 and SD =3.0). At the 12-month recall, the proportion of food consumption from category I was 6.4% in the implant-retained overdenture IOD group (Mean=4.0 and SD=3.0) and 6.5% in the conventional denture CD group (Mean=4.4 and SD=3.0). [Figure 4.3] and [Table 4.1].

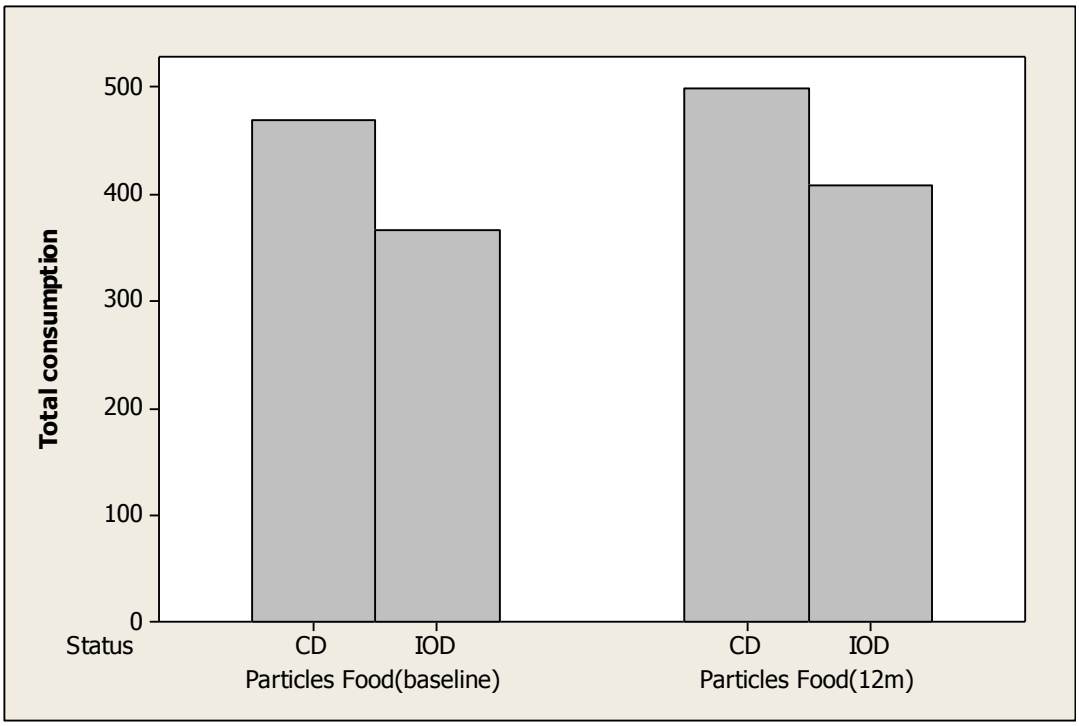

Figure 4.3 Total Category I foods consumed (Food with seeds, small particles or leavess). CD=Complete denture group.IOD=Implant overdenture group. 12M=12-Month follow up period. CD, n=114. IOD, n=103.

The proportion of food from category II (Hard food) at baseline was 6.7% in the implant-retained overdenture IOD group (Mean=4.3 and SD=2.1) and 6.4% in the conventional denture CD group (Mean=3.9 and SD= 2.2). At the 12 month recall, the proportion of food consumption from category II was 7.4% in the implant-retained overdenture IOD group (Mean= 4.7 and SD = 2.3) and 6.3% in the conventional denture CD group (Mean= 4.3 and SD= 2.5). [Figure 4.4] and [Table 4.1].

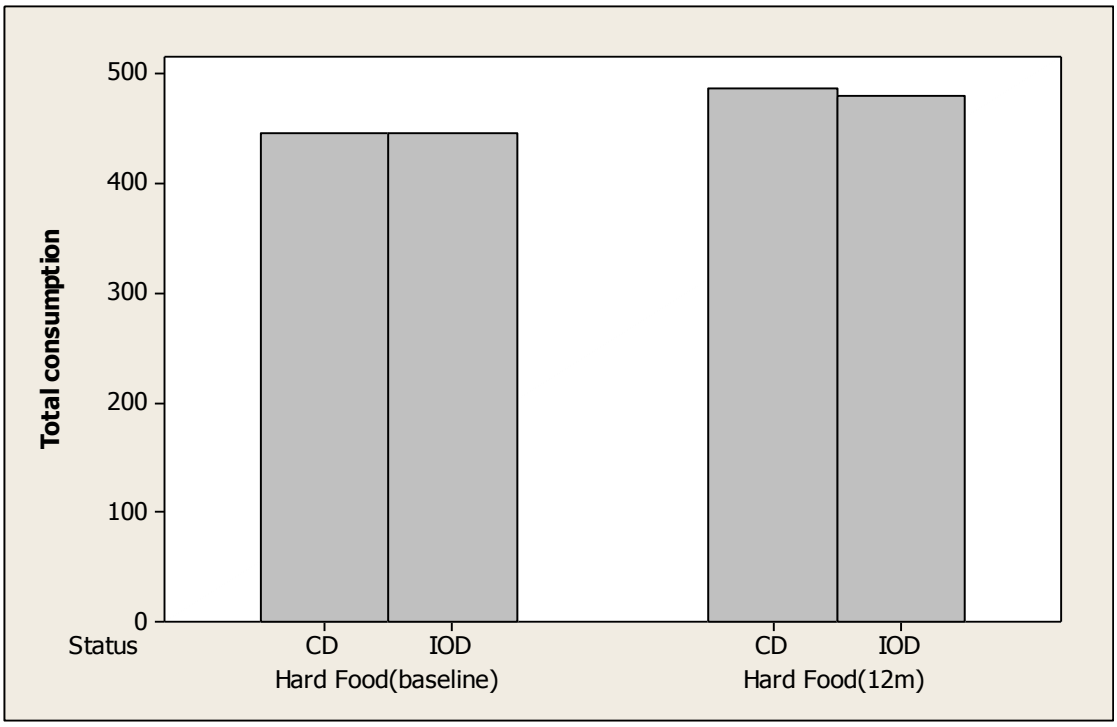

Figure 4.4 Total food consumed from Category II (Hard food). CD=Complete denture group .IOD=Implant overdenture group. 12M=12-Month follow up period. CD, n=114. IOD, n=103.

The proportion of food from the category III (Sticky food) at the baseline was 0.4% in the implant-retained overdenture IOD group (Mean=0.1 and SD=0.3), and 0.5% in the conventional denture CD group (Mean=0.3 and SD=1.0). At the 12- month recall, the proportion of food consumption from the group 3 was 0.2% in the implant – retained overdenture IOD group (Mean=0.1 and SD=0.3), and 0.1% in the conventional denture CD group (Mean=0.3 and SD=1.0). [Figure 4-5] and [Table 4-1].

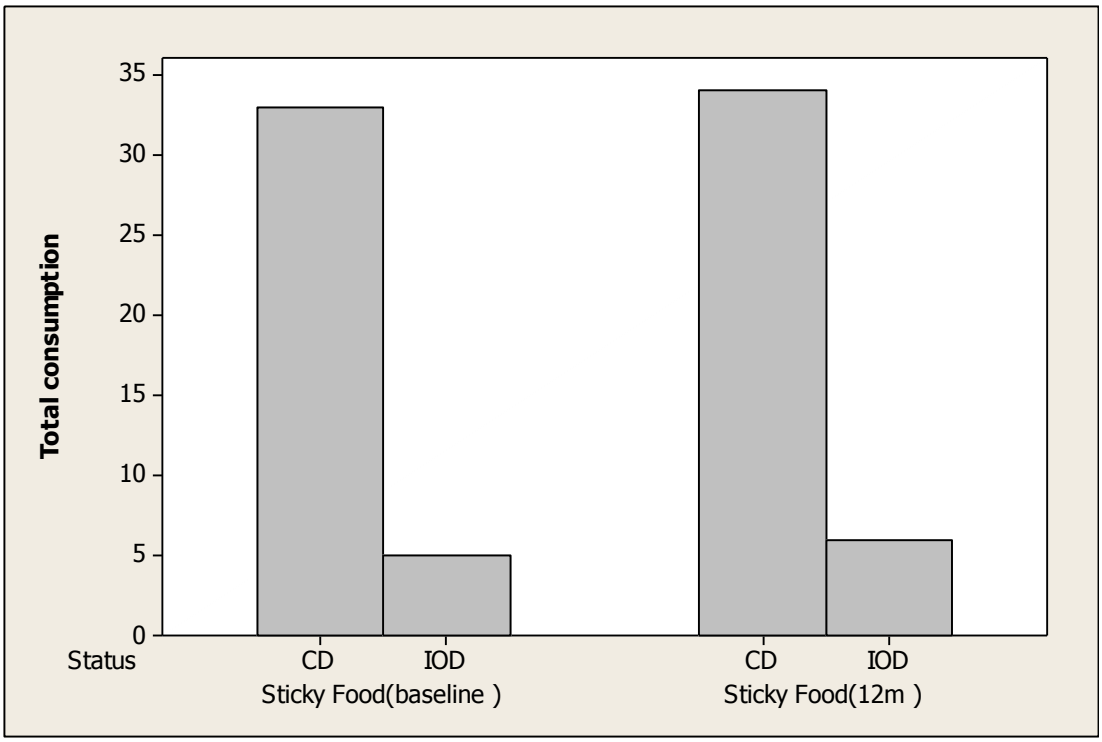

Figure 4.5 Total food consumed from Category III (Sticky food). CD=Complete denture group. IOD=Implant overdenture group. 12M=12-Month follow up period. CD, n=114; IOD, n=103.

Mann-Whitney U test was used to evaluate if there are inter-group changes at baseline and 12-month recall. The analysis failed to reject the primary hypothesis, which means changing the type of treatment from conventional denture to mandibular implant-retained overdenture will not change food choices and dietary quality of people who wear these prostheses. (*p=.50,* table 4-2). The analysis also failed to reject any of the three secondary hypotheses. That means that changing the prosthesis from conventional denture to mandibular implant-retained overdenture will not change the consumption of food with small particles or leaves, hard food, and/or sticky food (*p*=.30, *p=.20, p=.10* respectively) [table 4.2].

		Baseline			12 Month Follow-up		
Variable	Group	Median (Q1,Q3)	95% CI	*P value*	Median (Q1,Q3)	95% CI	*P value*
Total Food of All Categories	CD	8.0 (5.8,11.0)			9.0 (5.75,12.0)		
	IOD	5.0 (7.0,10.0)	(-1.0,1.0)	0.40	8.0 (6.0,12.0)	(-1.0,2.0)	0.50
Food with Seed, Particles, or Leaves (Category I)	CD	4.0 (2.0,6.0)			4.0 (2.0-6.0)		
	IOD	3.0 (1.0,5.0)	(0.0,1.0)	0.20	3.0 (1.0,6.0)	(0.0,1.0)	0.30
Hard Food (Category II)	CD	4.0 (2.0,6.0)			4.0 (3.0,6.0)		
	IOD	3.0 (4.0,6.0)	(-1.0,0.0)	0.20	4.0 (3.0,6.0)	(-1.0,-0.0)	0.20
Sticky Food (Category III)	CD	0.0 (0.0,0.0)			0.0 (0.0,0.0)		
	IOD	0.0 (0.0,0.0)	(-0.0,0.0)	0.20	0.0 (0.0,0.0)	(-0.0,0.0)	0.10

Table 4.2 Intergroup – Baseline and 12-month Median Daily consumption of selected food categories with results of Mann-Whitney U test for IOD and CD Groups. All ps= ns.

The following figure shows a comparison of the consumption of selected kinds of food according to their categories between the two groups in the 12-month follow up period. It can clearly be seen that consumption of sticky food (Category III) is significantly lower than consumption of the other two categories (food with small particles, seed or leaves, or hard food) [Figure 4.6].

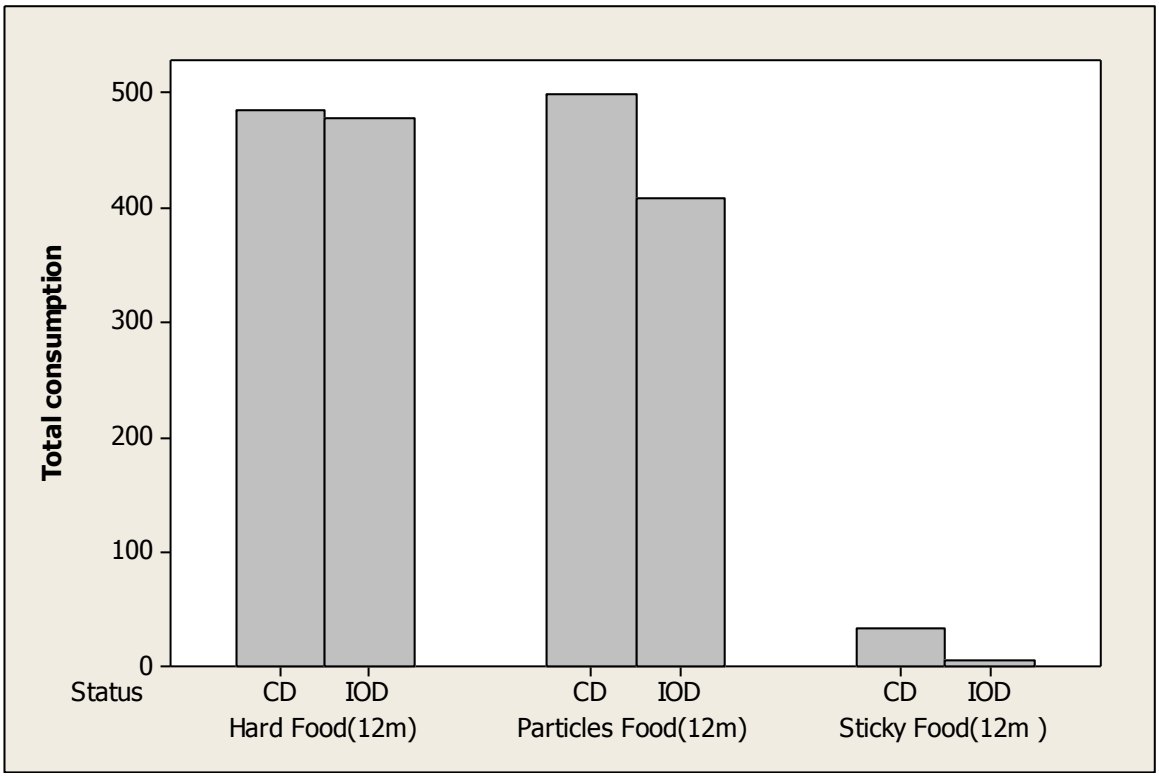

Figure 4.6 The total consumption of foods from the three categories.
CD=Complete denture group.IOD=Implant overdenture group. 12M=12-Month follow up period. CD, n=114. IOD, n=103.

CHAPTER 5: Discussion.

The current study was carried out as a secondary analysis of data gathered in a randomized controlled study in which the primary analysis aimed to determine whether there was an association between implant-retained overdenture treatment and blood plasma levels of homocysteine (tHcy), which is a nutritional marker for inflammation. We [220] found that using mandibular dentures retained by two implants for individuals accustomed to conventional dentures resulted in people reporting that they had greater chewing ability increase their choices of the foods they could eat. The implant-retained overdenture wearers reported that it was easier to consume hard, tough, and crispy food such as raw vegetables and fruits, and different types of meat. However, any associated dietary changes were not reflected in the nutritional intake that was calculated from their food diaries. Therefore, they found no significant effect of treatment with mandibular 2-implant overdentures.

The aim of this study was to assess whether there is difference in food choices and dietary quality between individuals who wear implant-retained overdentures and those who wear complete dentures.

To the best of our knowledge, this is the first randomised clinical trial that has a sufficient sample size to study the differences in dietary quality and intake between conventional denture and implant-retained overdenture wearers. It is also one of the first randomised studies that was designed to classify food into categories and address the question of whether food choices change from baseline and whether these choices are different in edentate elderly individuals who wear implant-retained overdentures or conventional dentures.

To determine which foods we would use in this study, we consulted a list of various kinds of food that are considered challenging to chew by edentate people based on previous studies [114, 117, 119, 206, 214-219]. We found no publication in which the listed foods had been classified into categories based on the properties that made them challenging to chew. Therefore, we did this through a survey of similar edentate individuals who had not participated in our study.

In doing this, we tried to avoid any bias or conflict by not using the same participants who were enrolled in the primary study, as well as those who would not have met the main study's inclusion/exclusion criteria. In other words, we chose participants who were similar to the individuals who were participants in the main study. Based on the results of that survey, we established the categories shown in Table 3-1.

We found that there is no statistical difference in the frequency of choice of foods in the chosen categories from baseline to 12 months whether a person wore implant overdentures or conventional dentures. Both groups have similar food choices and dietary quality among certain types of food that are considered challenging for elderly edentate people.

We also found that people who wear implant–retained overdentures show no significant difference in eating food with seeds, small particles or leaves, hard food, or sticky food compared to those who wear conventional dentures.

It was reported that the frequency of eating sticky foods was significantly lower than that of eating other challenging foods in both groups. It may be that sticky foods are problematic for both groups; no matter how well stabilized the prosthesis is. On the other hand, sticky foods are generally less healthy, so the fact that both groups avoid sticky foods, is actually beneficial

These findings agree with a few studies that we found in the literature of investigations using a similar design.

De Oliveira and Frigerio reported that implant-supported denture users are less susceptible to malnutrition when compared to complete denture users, due to the increased ability to chew various types of food in the implant-supported group [221]. However, food choices and dietary quality, along with improving nutritional intake, was not mentioned. That study did not mention how many implants supported the overdenture, whereas the overdentures in our study were retained by only 2 implants. Regardless, there were serious flaws in that study, including the fact that its sample was small and they did not carry out a sample size estimation; this could have led to an alpha error.

Sebring *et al* [222] also studied the nutritional outcomes of implant overdenture and conventional denture wearers. They reported no significant differences in intake of calories and 27 studied nutrients by implant-supported mandibular overdenture wearers and conventional denture wearers after receiving their new prostheses. A decrease in the percentage of calories derived from fat with a corresponding increase in carbohydrate calories was detected in both groups. It was also reported that around half of the subjects in both groups had an inadequate intake of dietary fibre and/or calcium, and 25% to 50% had a low intake of vitamins A, E, D, B6 and/or magnesium. Unfortunately, they did not carry out a dietary assessment; thus, we cannot compare their findings against ours.

Garrett *et al* [223] have reported no significant difference between users of fixed partial dentures supported by implants and users of removable partial dentures after analysing 30 nutritional variables of food intake before and after treatment. Moreover, both treatments increased the

intake of calories and 27 nutrients in the low caloric group and decreased the intake of calories and 27 nutrients in the high caloric group. However, the decrease in the caloric intake and eight nutrients including total proteins, fat, carbohydrates, and cholesterol were significantly greater in the fixed partial denture group than those in the removable partial denture group. Thus, although these investigators did measure food intake, they evaluated people with some teeth and only partial denture prostheses. Unfortunately, due to differences in analyses as well as in treatment populations, we cannot compare our results with theirs.

K. Muller *et al* [224] reported that no significant differences were found for frequency of cutting or chopping hard food (e.g.: apples, carrot, beef) between conventional denture and implant overdenture wearers. They also reported that both groups had a very a similar nutritional status and dietary intake, and that they ate the same types of foods, even though the complete denture wearers reported having more difficulty in chewing hard foods.

Our findings are in agreement with Allen *et al*[119], who reported that, although implant retained-dentures improve in the ability of chewing food and satisfaction, both implant retained and conventional denture wearers avoided eating challenging foods like whole raw carrots and apples.

Published literature on food choices of edentate people wearing prostheses is lacking; thus, it was not possible to include any additional comparative studies in this discussion.

Although mandibular implant-retained overdentures have been shown to lead to better improvement in chewing ability and overall patient satisfaction than conventional dentures, our similarity in findings between the two treatment groups can be discussed from many perspectives:

First, although almost the same types of food were eaten by both groups, the method of food preparation was different. It was reported in the primary analysis of the collected data [210] that there were differences in food preparation between the two groups. This information may assist in understanding the similarity of our findings, e.g., a person who cannot chew certain types of meat may cook it more to make it softer and be able to eat it.

Second, changing dietary habits that had been adopted many years previously is a complicated process involving multiple factors and, therefore, may take longer than 12 months to observe any difference[225].

Third, both groups received new prostheses during this study and, therefore, improvement was similar in food choice and dietary quality in both groups. Thus, differences in food choices were not found to be statistically significant.

This study has several strengths. First, participants were randomly selected following strict inclusion/exclusion criteria to ensure equivalence of both groups at baseline. Second, the number of participants in this study was larger than in any other similar study, thereby strengthening the validity of the findings. Third, data collection was carried out 12 months post-treatment, providing considerable time for all participants to become accustomed to the new prostheses and to allow ample opportunity for the participants to be able to eat various types of food before the dietary data were gathered. Fourth, although attrition was low, it was taken into consideration during the design and statistical analysis phase.

There were some study limitations: This study was not designed to evaluate participants' food choices. Moreover, a follow-up period of longer than 12 months might be needed to evaluate changes in food choices since changing eating habits or increasing the frequency of eating some

challenging foods could take a longer period of time. In fact, there are several factors that govern eating habits and food choices, including socioeconomic and behavioural ones [225]. It has also been suggested that dietary counselling is necessary to effect behaviour change in food intake [226]. We believe that, had we included individual dietary counselling, it could have led to very different findings in the present investigation.

5.1 Summary.

In summary, we found no significant difference in consumption of challenging foods between individuals wearing mandibular overdentures and those wearing conventional dentures.

These foods include those with seeds, small particles or leaves, as well as hard and sticky foods. Sticky foods were avoided more than the other challenging foods by both groups.

CHAPTER 6: Conclusions and Future Research.

Although the main study showed that patients who received mandibular implant-retained overdentures had a significant improvement in perceived ability to chew and improved food choice, no difference was detected in their consumption of various challenging foods as reported in this investigation.

We recommend that future studies consider studying foods that are challenging for edentate individuals, and that evaluation of eating habits and food choices by edentate elders should be assessed. In addition, studies should be followed up for periods longer than 12 months. This may allow for the evaluation of any possible changes in eating habits or food choices that may occur over a longer period.

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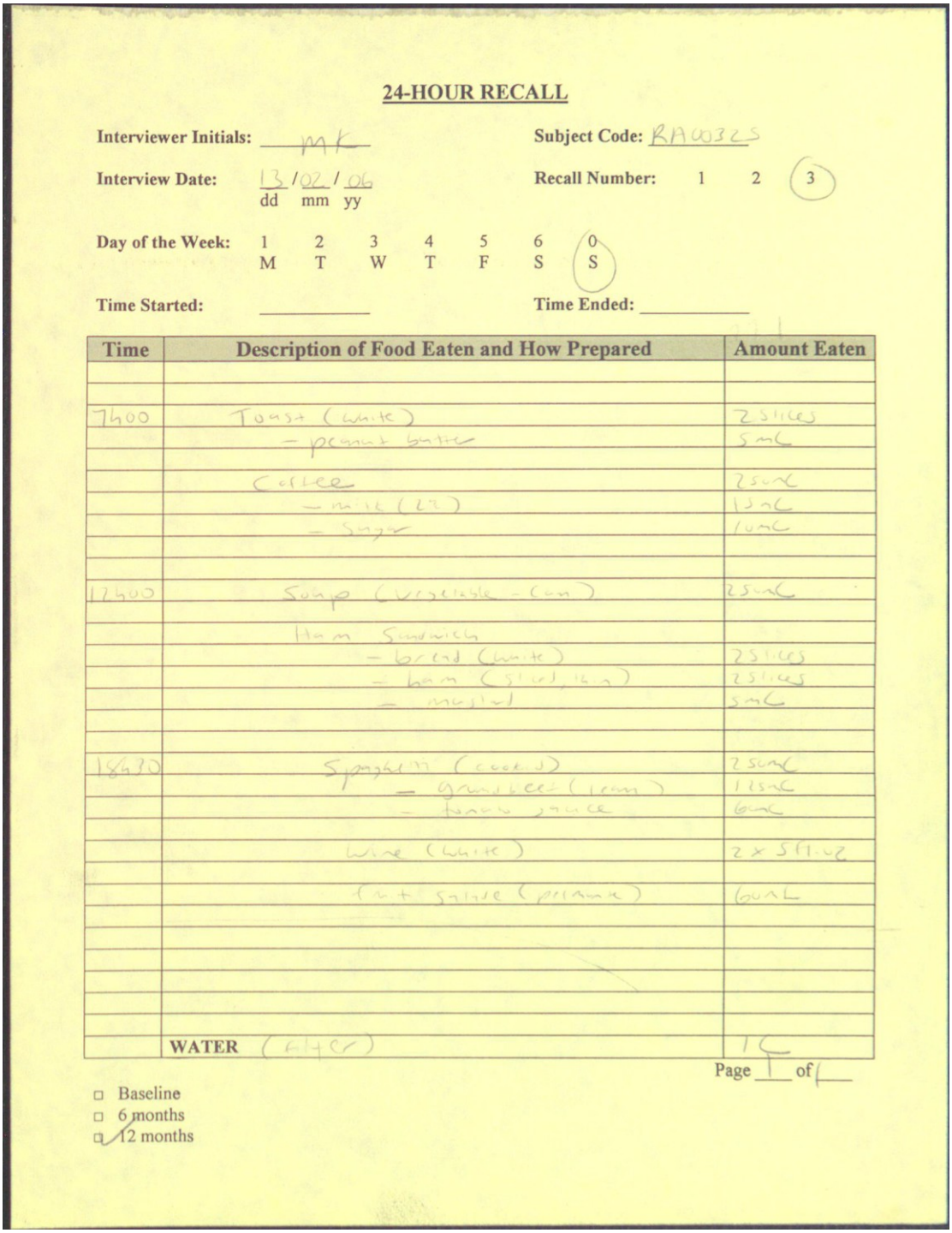
Chapter 8: Appendix

i- 24-HOUR RECALL Form



24-HOUR RECALL

Interviewer Initials: MK **Subject Code:** RA0325

Interview Date: 13 / 02 / 06 (dd mm yy) **Recall Number:** 1 2 (3)

Day of the Week: 1 M 2 T 3 W 4 T 5 F 6 S (0 S)

Time Started: _____ **Time Ended:** _____

Time	Description of Food Eaten and How Prepared	Amount Eaten
7h00	Toast (white)	2 slices
	- peanut butter	5 mL
	Coffee	250 mL
	- milk (2%)	15 mL
	- sugar	10 mL
12h00	Soup (vegetable - can)	250 mL
	Ham Sandwich	
	- bread (white)	2 slices
	- ham (sliced, lean)	2 slices
	- mustard	5 mL
18h30	Spaghetti (cooked)	250 mL
	- ground beef (lean)	125 mL
	- tomato sauce	60 mL
	Wine (white)	2 x 5 fl. oz
	Salad (private)	60 mL
	WATER (after)	1 L

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- ☐ Baseline
- ☐ 6 months
- ☑ 12 months