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The impact of supplementation with dietary fibers on weight loss: A systematic review of randomised controlled trials

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ABSTRACT

The prevalence of excess body weight has significantly increased, with recent estimates suggesting 1.9 billion people are overweight or obese worldwide. While intake of dietary fiber (mainly from plant-based foods) is associated with improved weight management over time, it is uncertain whether dietary fiber isolates will benefit weight loss. The present study aimed to systematically assess the current evidence that dietary fiber supplementation can impact on weight loss in overweight adults. Blinded, randomised-controlled trials were retrieved from Scopus and Cochrane Central Register of Controlled Trials databases. Studies with free-living, overweight adult participants and fibre supplementation in various forms (i.e. as pills, capsules or powder mix formats) were included. A total of 32 trials were identified that met these criteria. Meta-analysis of statistically pooled data for chitosan (n=6) found significant increases in weight loss (effect size −0.42, 95% confidence interval: −0.81 to −0.03, P < 0.001) in treatment groups compared with control groups. For glucomannan (n=5), non-significant difference was found (effect size −0.58, 95% confidence interval: −1.52 to 0.35, P < 0.001). Risk of bias within included studies appeared to be low with mean scores of > 3 on the Jadad scale and 13 studies scoring the highest possible value. Evidence on the potential impact of supplementation with other fibre types on weight loss was limited by a low number of studies and varied methodological approaches. Further research is recommended to explore these underlying issues to improve the paucity of evidence. A number of elements of study design should also be carefully considered in future work.

1. Introduction

Obesity is defined as the excessive accumulation of fatness within the human body that is strongly associated with negative impacts on health and physiological function (Garrow, 1988; Komaroff, 2016). Global obesity and overweightness prevalence rates were estimated to exceed 1.9 billion of the population above 18 years of age as of 2014 (World Health Organization, 2016).

Previous observational studies have highlighted strong associations between obesity and adverse health outcomes in adults, specifically, major chronic diseases such as cardiovascular disease, type II diabetes mellitus and cancers, which consequently are contributory to a diminished quality of life (e.g. disabilities, psychosocial instabilities), increased mortalities and detrimental socio-economic impacts (Dixon, 2010; Mokdad et al., 2003; Rush, LeardMann, & Crum-Cianflone, 2016). The increasing prevalence of obesity, coupled with its association as a pre-disposing risk factor for major non-communicable diseases and detrimental consequences, further highlights the magnitude of the obesity epidemic as a major public health concern (J. S. Garrow, 1992; Prentice, 2006). Both body mass index (BMI) and waist circumference are well-established estimates of body fatness that can be effectively used to evidence obesity-related disease risk (Janssen, Katzmarzyk, & Ross, 2004; World Health Organization Expert Consultation, 2004).

Conventional weight loss strategies tend to be through reducing dietary energy intake and increasing physical activity levels. These approaches have been previously reported to have issues with low compliance and may also lead to highly variable effects high intra-individual variability, limiting the efficaciousness of these treatments (Frood, Johnston, Matteson, & Finegood, 2013; Hill, Wyatt, & Peters, 2012). While changes to diet and lifestyle remain the front line, specific products to help in weight loss would ideally be evidenced to be effective across a wide spectrum of individuals, be easy to incorporate into the diet and have minimal unwanted side effects.

The term dietary fiber describes a range of indigestible dietary carbohydrates (Jones, 2014). Beyond the inherent cellulose, hemicellulose and pectin consumed as components of plant-based foods, a wider variety of types of (integral or added) dietary fiber are found in a

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range of foods products including β-Glucan, pectin, gums, mucilage, alginate and psyllium (Jones, 2014; Papathanasopoulos & Camilleri, 2010).

Dietary fiber supplementation has previously been suggested as a nutraceutical aid to benefit weight loss (Howarth, Saltzman, & Roberts, 2001; Slavin, 2005). There are several plausible mechanisms by which this hypothetical action of fibre supplementation could occur, which have been supported by evidence from human and animal studies; a) increased satiety and satiation through bulking and intragastric gelation and/or regulation of cephalic and peripheral satiation-signalling hormones (e.g. ghrelin, cholecystokinin, peptide YY), thus reducing increasing feelings of fullness during the meal (Wanders et al., 2013); b) decreased energy uptake as a result of fibre being indigestible and potentially interfering in the digestion or absorption of dietary macronutrients (Chater, Wilcox, Pearson, & Brownlee, 2015); c) stimulation of faecal excretion of bile acids, driving a metabolic flux in the hepatic production of bile (Zacherl, Eisner, & Engel, 2011); d) increased energy expenditure (i.e. dietary-induced thermogenesis) during the digestion process, potentially attributable to the increase in gastrointestinal motility (Pereira & Ludwig, 2001); e) Acting as a substrate that favourably alters the gut microbiota or the profile of fermentation by-products with downstream effects on gastrointestinal hormone release and changes to whole body metabolism (DiBaise, Frank, & Mathur, 2012).

A large number of observational studies have suggested that dietary fiber intake is inversely associated with reduced weight gain throughout the life-course (Anderson et al., 2009). Improved body weight management in individuals that habitually consume high amounts of dietary fiber in plant-based foods would also not necessarily suggest that intake of isolated dietary fibers as supplements would benefit weight loss in overweight individuals. As such, randomised controlled trials (RCTs) relating to dietary fiber isolates/supplements represent a necessary research approach to explore whether specific fibre isolates can impact on weight loss. A previous systematic review of systematic reviews conducted by Onakpoya and colleagues (2011) further concluded that the meta-data does not provide strong supporting evidence for dietary fiber supplementation benefitting body weight reduction (Onakpoya, Wider, Pittler, & Ernst, 2011). However, as the physicochemical properties of dietary fibers are likely to affect their biological activity (Wilcox, Brownlee, Richardson, Dettmar, & Pearson, 2014), it is important to consider individual dietary dietary fibers separately. A previous systematic review of RCTs (Pittler & Ernst, 2004) highlighted a paucity of evidence to support weight loss effects of a handful of types of dietary fiber (chitosan, glucomannan, guar gum and psyllium).

There appears to be a need for a more up-to-date screening of a wider range of dietary fibers for their putative effects on weight loss. The present study aimed to evaluate the current RCT evidence base for the impact of dietary fiber-based supplements on body weight and fatness. To do this, a systematic approach was undertaken to screening existing studies across a diverse range of fibre types in overweight or obese adults, with change in body weight, BMI and waist circumference measurements being the outcomes of interest. Qualitative and quantitative consideration of study design and comparison between fibre types was also a key objective for this study through cross-tabulation and Jadad scoring to consider the potential for reporting bias.

2. Methods

2.1. Search strategy

The systematic, electronic literature search of Scopus and The Cochrane Central Register of Controlled Trials (CENTRAL) databases was conducted to identify relevant randomised, controlled trials (RCTs). Scopus was selected as it indexes quantitative and qualitative articles with 100% MEDLINE, EMBASE and Compendex coverage while CENTRAL was selected as a rich, comprehensive source of RCTs (Crumley, Wiebe, Cramer, Klassen, & Hartling, 2005). The search strategy was performed on both databases for RCTs between October 2016 and December 2016.

For both databases, key search terms within titles and abstracts were, “dietary fiber”, “guar”, “glucomannan or konjac”, “psyllium or ispaghula”, “pectin”, “alginate or alginic or algin”, “inulin”, “polydextrose”, “wheat dextrin”, “bran”, “β-glucan or beta-glucan or b-glucan”, “gum”, “lignin”, “chitosan or chitin”. Additional nomenclature of dietary fiber analogues was incorporated into key search terms to further encompass a wider range of studies. Search terms for specific dietary fiber analogues were based on the European Food Safety Authority (EFSA) panel scientific opinion for dietary fibers that were considered for health claims pertaining to weight loss (European Food Safety Authority Panel on Dietetic Products Nutrition & Allergies, 2010). For Scopus, additional filters were applied to remove studies that were not within the defined criteria. A filter utilising index terms and keywords derived from Medical Subject Headings (MeSH) and EMTREE terms was applied in the search approach to include studies that were of a RCT design (National University of Singapore Libraries, 2017). Built-in filters in Scopus were utilised to eliminate studies within non-relevant areas (e.g. Engineering, Computer Science, Arts and Humanities, Business Management and Accounting, Veterinary) to further stratify search results.

2.2. Inclusion criteria

Studies were required to be blinded, randomised controlled trials (RCTs) of parallel or crossover designs conducted on overweight or obese, free-living adult (aged 18 years or above) participants based on WHO guidelines for BMI cut-offs (World Health Organization Expert Consultation, 2004; World Health Organization, 2000). Each included study had to follow an RCT design where the treatment group were exposed to dietary fiber supplements previously linked to improved weight management (i.e. guar gum, glucomannan, psyllium, pectin, alginate, inulin, polydextrose, wheat dextrin, bran, β-glucan, gum, lignin, chitosan). Supplementation could be in the form of pills, capsules, added as a powder mix to water/juices as a pre-load formula for consistency in supplement exposures. Studies were only included if weight, BMI and/or WC was assessed as either primary or secondary measures of outcomes (Vazquez, Duval, Jacobs, & Silventoinen, 2007).

Studies were excluded if they were observational studies (e.g. cross-sectional, cohort, longitudinal or case-control studies), systematic reviews, meta-analyses, protocols of RCTs, *in vitro* studies or animal studies. Exclusion criteria include studies of non-English language due to potential misinformation from poor translation, participants with chronic illnesses (i.e. cancers, cardiovascular diseases) or have undergone surgical procedures that may affect digestibility or gastrointestinal functions which may interfere and contribute to clinical heterogeneity (West et al., 2010). RCTs with partial interventions or multiple interventions (co-intervention for either or both intervention groups) were excluded (Prasad, 2013). Studies were further excluded if the type, dosage, frequency or time-frame of the treatment was not indicated clearly to eliminate comparison issues during analysis of studies. Studies were also excluded if comparator groups were absent or not indicated (Higgins, Green, & Scholten, 2008).

There were no restrictions based on the socio-economic status, race and gender of study participants, study setting (i.e. country, state), duration and timing of delivery, dosage/intensity (i.e. no critical dose below which will be considered for exclusion) to allow a comprehensive analysis of available empirical data within these study parameters. Studies were also not restricted by publication year or status to reduce risk of publication bias, with both databases searched from their inceptions until December 2016 (Rothstein, Sutton, & Borenstein, 2006).