Evidence Mapping: Resistant Starch Interventions and Health Outcomes

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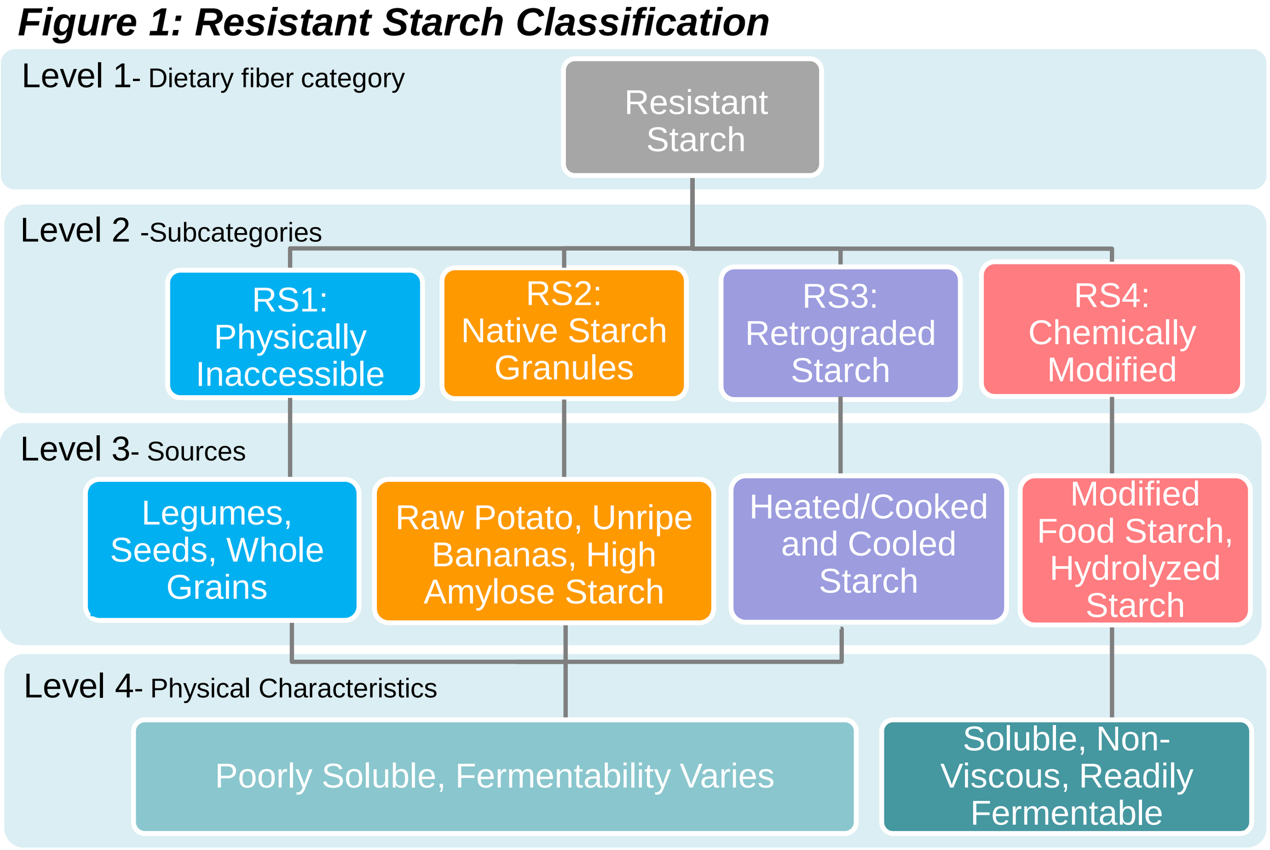
Abstract

Resistant starch has potential health benefits including improving glycemic control, increasing satiety, and promoting gut health. The aim of this project was to use evidence mapping methodology to summarize published data on the relationship between resistant starch consumption and several physiological health outcomes. A newly developed fiber database, comprised of human intervention studies published from 1946 to September 2013, identified 57 publications detailing dietary interventions using resistant starch. Within the 57 publications, 69 resistant starch interventions were identified, which varied widely in description of type and/or source of resistant starch. Descriptive analyses were performed to summarize study design characteristics, exposures, and outcomes. Weighted scatter plots were used to visualize gaps in the current body of research. The majority of studies were randomized crossover designs (82%) in adult populations (93%). The physiological health outcomes most frequently studied were colonic fermentation/short chain fatty acid production (18%), postprandial glucose and insulin metabolism (18%), and fecal bulking/laxation (11%). There was little available information on blood pressure, blood lipids, or transit time. Only 3 studies (5%) had a sample size of more than 50 subjects, and 40% of interventions were acute studies that lasted less than 2 days. The effect of resistant starch on health outcomes among overweight, obese, or metabolically at-risk subjects is lacking, reported in only 14% of studies. Moving forward, dietary intervention studies examining the effect of different resistant starches could be of longer duration in a wider range of subjects and health outcomes, and a meta-analysis could be employed to synthesize the research and strengthen the cumulative evidence on this topic.

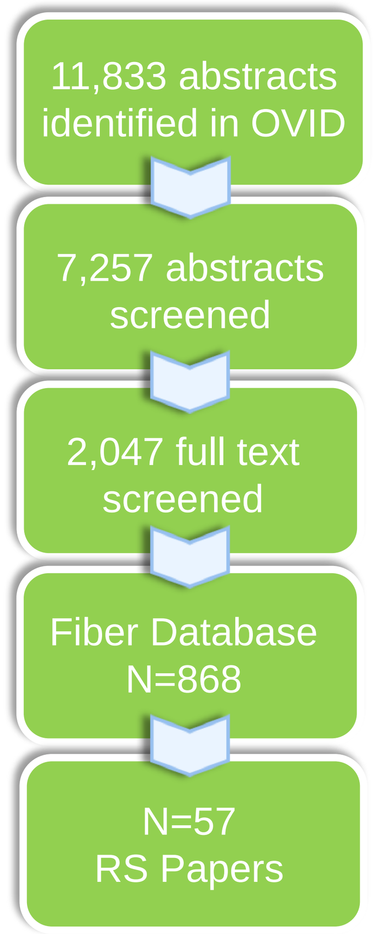
Background

Figure 1: Resistant Starch Classification



Dietary fiber research has focused on promising outcomes associated with exposure to resistant starch. There are four different kinds of resistant starch (RS): physically inaccessible (RS1), native starch granules (RS2), retrograded starch (RS3), and chemically modified starch (RS4). Each of these is derived from a variety of different foods with different chemical properties. RS1 is also known as indigestible resistant starch and can typically be found in legumes, seeds, and whole grains. RS2, on the other hand, occurs in its native, granular form such as unripe bananas, high-amylose starch, and raw potatoes. RS3 is a type of starch known as retrograded starch, which has been heated and then cooled leading to a less soluble product, found in certain kinds of bread and rice. All three of these starches are classified as insoluble fibers, as they do not dissolve in water and primarily function to provide bulking throughout the process of digestion. In contrast, RS4, or starch that has been chemically modified to resist digestion, is considered a soluble fiber due to its ability to dissolve in water and to be readily fermented in the colon by microbiota. This starch includes foods that would not be found in nature, such as modified food starches or processed grains.

Methods



Development of the Evidence Map:

1) Conducted a systematic literature search in OVID Medline for fiber interventions with at least one of nine health outcomes identified at the Ninth Vahouny Fiber Symposium by ILSI North America & ILSI Europe in 2010 (listed in Table 1)
2) Screened abstracts applying broad inclusion criteria (see Table 1)
3) Screened full texts of accepted abstracts, applying additional exclusion criteria (see Table 1)
4) Extracted data from articles into web-based repository, SRDR™ (http://srdr.ahrq.gov)
5) Restricted SRDR database to all publications with at least one fiber exposure classified as a resistant starch

Data Analysis

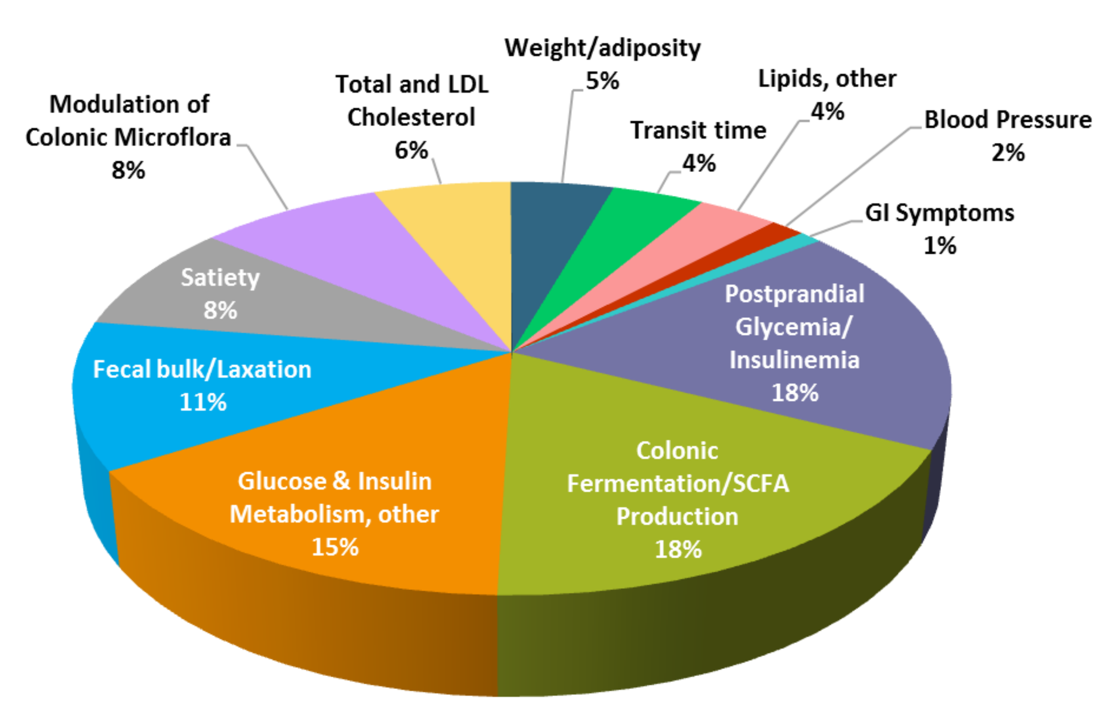
- Descriptive analyses were performed to characterize study design and outcomes examined
- Weighted scatter plots were used to visualize major resistant starch groups by the outcomes studied and sample size

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
-Published 1946- September 2013 -Published in English -Abstract contained a fiber term and one of the following Vahouny heath outcomes: 1. Total & LDL cholesterol 2. Post-prandial glucose & insulin 3. Blood pressure 4. Fecal bulk & laxation 5. Transit time 6. Colonic fermentation & SCFA production 7. Modulation of colonic microflora 8. Weight/adiposity 9. Increased satiety	-Reviews, bibliographies, case reports -Observational studies -Intervention was via tube feeding or enteral nutrition -Population was infants (<3 years), pregnant or breastfeeding women, has any type of cancer, bowel disease, renal failure, or other chronic disease condition -Intervention has no concurrent control -Fiber dose not clearly reported -Intervention not sufficiently controlled to isolate the effect of fiber -Animal-only studies -In vitro studies

Results

Figure 2. Distribution of Reported Health Outcomes



Results Continued

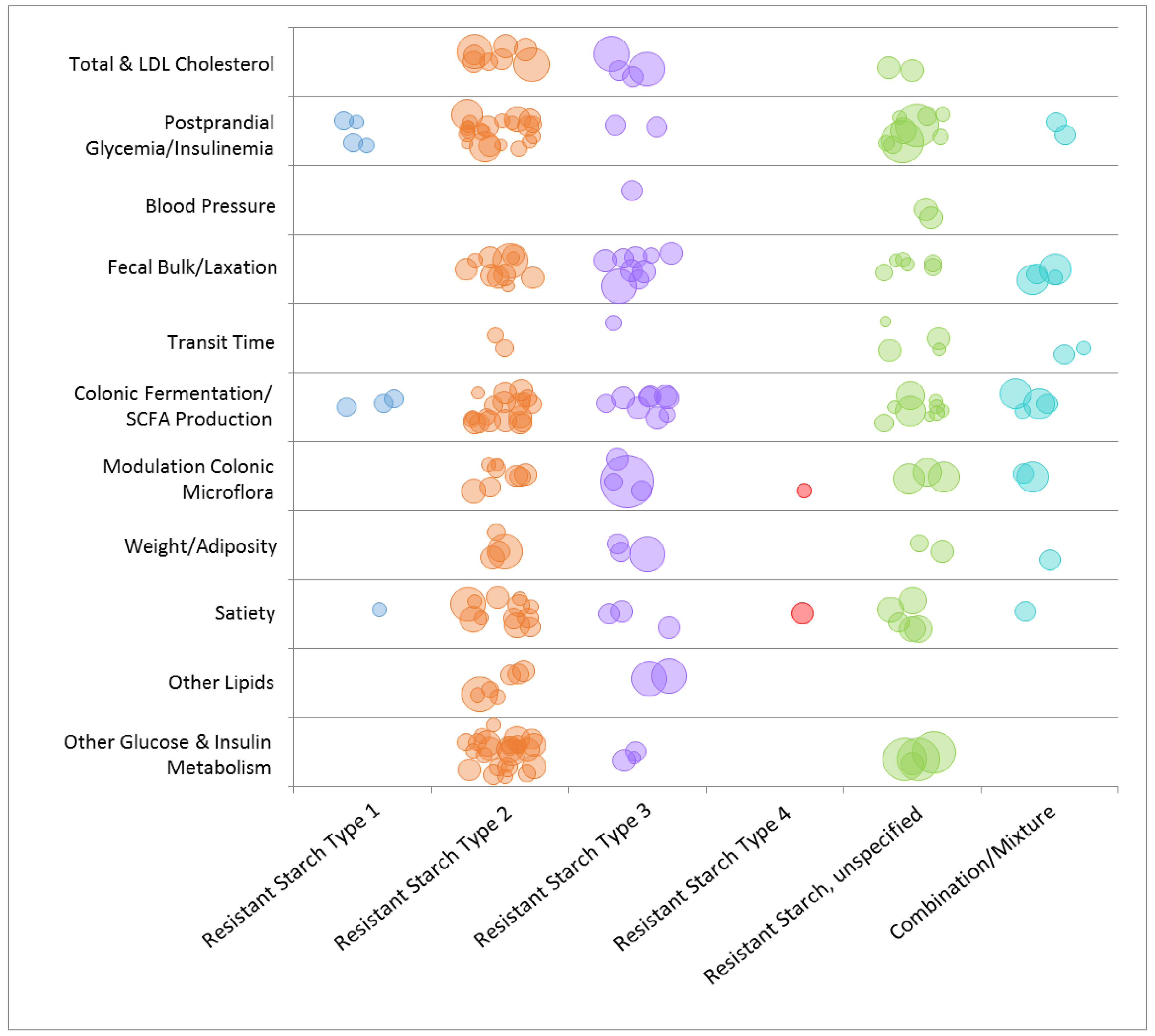
Table 2. Study Design Characteristics (n=57)

Characteristic	n (%)
Design	
Randomized Crossover	47 (82)
Randomized Parallel	7 (12)
Controlled Crossover, un-specified randomization	2 (4)
Non-Randomized Controlled Trial	1 (2)
Sample Size	
0 ≤ n ≤ 49	54 (95)
n ≥ 50	3 (5)
Diet Type	
Isocaloric/Maintenance	26 (46)
Acute Feeding	23 (40)
Unspecified	8 (14)

Table 3. Study Population (n=57)

Characteristic	n (%)
Age	
Adults (20+ Years)	53 (93)
Adults (20+ Years) & Adolescents (12-19 years)	4 (7)
Baseline Health	
Healthy	47 (82)
Obese/Overweight	4 (7)
Diabetes or At Risk of Diabetes	3 (5)
Hyperlipidemia	1 (2)
Other	2 (4)
Region	
Asia	4 (7)
Australia	8 (14)
Europe	29 (51)
North America	16 (28)

Figure 3. Health Outcomes Examined by Resistant Starch Fiber Types[1]



[1]Each bubble represents a single publication, and the size corresponds to the study sample size. Publications may be represented more than once if multiple fiber types or outcome groups were examined but are only represented once within any given cross-sectional category. Actual bubble placement within each category is random.

Table 4. Distribution of RS Exposures

Fiber	n (%)
Resistant Starch 1	3 (4)
Resistant Starch 2	31 (45)
Resistant Starch 3	12 (17)
Resistant Starch 4	2 (3)
Resistant Starch, unspecified	15 (22)
Combination/Mixture	6 (9)

- Most frequent type of RS2 was high-amylose maize starch (n=21)
- Most frequent type of RS3 was retrograded high-amylose maize starch (n=7)

Summary of Results

- The Fiber Database had **57 publications** reporting RS as at least one of the exposures, and a total of **69 RS exposures**.
- The most studied outcomes were postprandial glycemia/insulinemia and colonic fermentation/SCFA production, each comprising 18% of papers. [Figure 2]
- A majority of the studies were randomized crossover designs (82%) and had a sample size between 1 and 49 subjects [Table 2]
- 40% of studies were acute feeding studies, which primarily measured postprandial effects of RS supplements.
- 35% of interventions lasted 1-4 weeks, while 25% lasted over 4 weeks (the longest duration was 12 weeks).
- 82% of studies were in healthy subjects, 93% were 20 years of age or older, and 51% of studies were conducted in Europe. [Table 3]
- RS2 and RS3 have been well studied in a number of health categories, whereas RS4 is less well represented. [Figure 3]

Conclusions

- While RS2 and RS3 are commonly studied, studies examining RS4 are lacking
- The majority of studies were in healthy subjects. Future research should further examine subjects who are metabolically at risk.
- This database allowed us to quickly identify specific RS exposures and health outcomes based on how authors reported them.

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