Universidade de São Paulo
Faculdade de Saúde Pública

Desenvolvimento de *software* para monitoramento de saúde no *Nutritionists' Health Study*: aplicação na análise da relação entre aquisição de conhecimento em nutrição e dieta

Luciana Gavilan Dias Folchetti

Tese apresentada ao Programa de Pós-Graduação em Nutrição em Saúde Pública para obtenção de título de Doutora em Ciências

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1. Informática em saúde
2. *Software*
3. Epidemiologia nutricional
4. Composição corporal
5. Dieta
6. Análise nutricional de populações

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APRESENTAÇÃO

O projeto de pesquisa que deu origem a esta tese de doutorado foi aprovado pelo Comitê de Ética em Pesquisa da Faculdade de Saúde Pública da Universidade de São Paulo. Este foi elaborado a partir de projeto-matriz intitulado "ESTUDO DE SAÚDE DE NUTRICIONISTAS FASE 1 – ESNUTRI (NUTRITIONISTS' HEALTH STUDY – NUTRIHS) DA FSP-USP", apoiado pela Fundação de Amparo à pesquisa do Estado de São Paulo – FAPESP (processo No 2015/10045-7), sob a coordenação da Orientadora.

No capítulo **Introdução** são feitas considerações que fornecem o embasamento teórico deste trabalho. Apresentam-se a **Justificativa** e a **Hipótese** que nortearam a realização da tese. Na sequência, os **Objetivos** estão explicitados e o **Método** é apresentado de forma detalhada.

Atendendo às normas deste Programa de Pós-Graduação, a tese de doutorado inclui **Artigos**, resultantes do trabalho realizado, submetidos ou a ser submetido no idioma e formato adequados à publicação.

Utiliza-se do capítulo de **Considerações Finais** para consolidar as principais contribuições que o presente estudo trouxe ao conhecimento na área, incluindo as **Conclusões**.

Ao final, encontram-se as **Referências Bibliográficas** referentes aos capítulos iniciais desta dissertação, seguidas dos **Anexos** (documentação do *software* ora desenvolvido para submissão de seu registro) e da primeira página do **Currículo Lattes**.

RESUMO

Folchetti, LD. Desenvolvimento de *software* para monitoramento de saúde no *Nutritionists' Health Study*: aplicação na análise da relação entre aquisição de conhecimento em nutrição e dieta [tese]. São Paulo: Faculdade de Saúde Pública da USP; 2016.

Introdução: Nicho interessante de pesquisa sobre o papel de hábitos de vida na saúde são os nutricionistas e estudantes de nutrição. Nesse sentido, surge o Nutritionists' Health Study (NutriHS) na FSP-USP. Estudos desta natureza geram quantidade apreciável de informação, sendo desejável o uso de tecnologia para facilitar a obtenção e processamento de dados. **Objetivos:** O conjunto dos objetivos desta tese, que vão desde a criação de sistema *web* até sua aplicação no NutriHS, foram: **1)** analisar *softwares* internacionalmente disponíveis, voltados à coleta e análise de dados sobre nutrição e alimentação; **2)** desenvolver e implementar o sistema *web*, o *e*-NutriHS; **3)** elaborar a documentação do sistema *web*; **4)** proceder a validação os dados coletados pelo *e*-NutriHS; **5)** comparar hábitos de vida (dieta e atividade física), medidas antropométricas e perfil bioquímico de estudantes de Nutrição e nutricionistas. **Métodos**: Realizou-se busca sistemática de estudos que utilizavam sistemas informatizados baseados na *web*. No desenvolvimento do *e*-NutriHS empregaram-se linguagens de programação livres: para o banco de dados utilizou-se MySQL 5.0 server via phpMyAdmin, localhost via UNIX socket e para a camada de apresentação Jquery 1.8, PHP 5.6, CSS e HTML 5. A documentação incluiu fluxogramas, arquitetura, código fonte e abordagem IBM Rational Unified Process, permitindo o desenvolvimento guiado por casos de uso, atendendo às recomendações do Instituto Nacional de Propriedade Industrial. Implementou-se a coleta de dados do NutriHS sobre hábitos de vida, eventos precoces da vida, saúde e clínico-laboratoriais, de estudantes de Nutrição em diferentes períodos do curso (1ª metade e 2ª metade) e graduados, por meio eletrônico e presencial. Bland-Altman e Kappa foram usadas para análises de concordância entre dados referidos e aferidos. Subgrupos de participantes foram comparados quanto a diversas variáveis (incluindo índice de dieta saudável) por ANOVA. **Resultados:** A busca das ferramentas de coleta eletrônica de dados de nutrição resultou em 10 estudos. A documentação do e-NutriHS incluiu detalhamento de fluxogramas, arquitetura, código fonte e casos de uso, atendendo às recomendações para registro de *software.* 723 indivíduos completaram dados autorreferidos no sistema e 228 realizaram antropometria, medidas de pressão arterial, composição corporal e coleta de materiais biológicos. Detectaram-se fortes correlações entre os valores antropométricos relatados e aferidos. A comparação de subgrupos mostrou tendência a menor consumo de energia, colesterol e carne vermelha e maior consumo de frutas & verduras nos grupos com maior duração da exposição a conhecimentos em nutrição. Os graduados apresentaram melhor escore de componentes do índice de dieta saudável e melhores índices lipídicos. Tais índices associaram-se ao consumo de frutas & verduras e inversamente ao de grãos refinados. **Discussão**: Instrumentos disponíveis na literatura apontam o meio eletrônico como de utilidade para condução de pesquisa em epidemiologia nutricional. O *e*-NutriHS atendeu adequadamente aos propósitos, motivando encaminhar seu registro de *software*. Com ferramenta eletrônica amigável, o NutriHS destacou-se como importante iniciativa de pesquisa em nutrição. Sugeriu que aquisição de conhecimento e habilidades traz benefícios clínicos que poderão, no longo prazo, reduzir o risco cardiometabólico. Conclui-se que o desenvolvimento do *e*-NutriHS proporcionou rápida implementação do NutriHS, gerando dados de alta qualidade e baixo custo. Abrem-se perspectivas de testar hipóteses sobre mecanismos de doenças e intervenções na sua fase longitudinal que poderão ser úteis para a saúde pública.

Descritores: bioinformática, *software*, epidemiologia nutricional, análise nutricional de populações, dieta, composição corporal.

ABSTRACT

Folchetti, LD. [Software development for health monitoring in the Nutritionist 'Health Study: application in the analysis of the relationship between literacy in nutrition and diet] [thesis]. São Paulo: Faculdade de Saúde Pública da Universidade de São Paulo; 2016. Portuguese.

Introduction: An interesting field of research on the role of lifestyle on health involves undergraduates and graduates of Nutrition Colleges. In this sense, emerges the Nutritionists' Health Study (NutriHS) in the FSP-USP. This kind of study generates appreciable amount of information requiring technology to facilitate the data collection and processing. **Objectives:** The objectives for the development of this thesis began by programing a computerized system to its application in NutriHS. They were: **1)** to analyze internationally available softwares addressed to the collection and analysis of data on nutrition; **2)** to develop and implement the web system, e-NutriHS; **3)** to develop the web system documentation; **4)** to validate the data collected by NutriHS system; **5)** to compare lifestyle habits (diet and physical activity), anthropometric measurements and biochemical profile of Nutrition undergraduates and nutritionists. **Methods:** A systematic search of epidemiological studies using web-based systems was performed. For the development of the *e*-NutriHS system free programming languages were employed: MySQL 5.0 for database server via phpMyAdmin, localhost via UNIX socket; and jQuery 1.8, PHP 5.6, CSS and HTML 5 for the user's layer. Its documentation included detailed flowcharts, architecture, source code and the IBM Rational Unified Process approach, according to the National Institute of Industrial Property recommendations. Electronic data collection of the NutriHS participants on lifestyle, early life events, health and clinical laboratory from the undergraduates at different stages of course (1st half and 2nd half) and graduated, as well as face-to-face data collection, were implemented. Bland-Altman and Kappa were used for correlation analysis between reported and measured data. Subgroups of participants were compared according to a number of variables (including healthy eating index) by ANOVA. **Results:** Ten studies were selected in the search of web-based instruments. The *e*-NutriHS documentation included flowcharts, architecture, source code and use cases, taking into account the recommendations for software registration. 723 subjects completed self-reported data and 228 had measurements of anthropometry, blood pressure, body composition and collection of biological materials taken. Strong correlations were detected between reported and measured anthropometric values. In subgroups comparisons, a trend to lower energy and cholesterol red meat and higher fruits and vegetables intakes were found in groups with longer exposure to nutrition knowledge. The graduated group had better scores of some components the health eating index and better lipid indices. Lipid indices were associated with the intake fruits & vegetables and inversely with refined grains. **Discussion:** The systematic review indicates that web-based instruments are useful for conducting research in nutritional epidemiology. The *e*-NutriHS met its purposes appropriately, which led to referral to the software registration. The NutriHS has represented a major initiative research in nutrition. This suggested that acquisition of knowledge and skills reflects in clinical benefits that could reduce long term cardiometabolic risk. We conclude that the e-NutriHS development accelerate the NutriHS implementation, generating high-quality low-cost data. Perspectives of testing hypotheses about the mechanisms of nutrition-related diseases and interventions in the longitudinal phase are opened with potential use in public health.

Keywords: bioinformatics, software, nutritional epidemiology, nutritional analysis of populations, diet, body composition.

SUMÁRIO

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SIGLAS UTILIZADAS

24hr – *24-hour dietary record*

AIP – *Atherogenic index of plasma*

ASA 24 – *Automated self-administered 24-hour recall*

BD – Banco de dados

BMI – *Body mass index*

BWHS – *Black Women's Health Study*

CS – Centro de Saúde

CSS – *Cascading Style Sheets*

COEP – Comitê de Ética em Pesquisa

CRI – *Castelli's risk index*

DB – *database*

DCNTs – Doenças crônicas não-transmissíveis

DXA - *Dual-emission X-ray absorptiometry*

ELISA – *Enzyme-linked immunoenzymatic assay*

ELF –Early Life Factors Study

EPIC – *European Prospective Investigation into Cancer*

FFQ – *Food frequency questionnaire*

FSP/USP – Faculdade de Saúde Pública, Universidade de São Paulo

HEI – *Health eating index*

HPFS – *Health Professionals Follow-up Study*

HTML – *HyperText Markup Language* – Linguagem de marcação de hipertexto

IARC – *International Agency for Research of Cancer*

IMC – Índice de massa corporal

IPAQ – *International physical activity questionnaire*

LIME – *Lifestyle and Immune Function Study*

NCCD – *Non-communicable chronic diseases*

NCI – *National Cancer Institute*

NHS – *Nurses' Health Study*

NINFEA – *Nascita e INFanzia gli Effetti dell'Ambiente*

NmeS – *Nurses and Midwives e-cohort Study*

NutriHS – *Nutritionists' Health Study*

OMS – Organização Mundial da Saúde

PHP – *Personal home page*

PRIDE – *PRegnancy and Infant Development*

QFA – Questionário de freqüência alimentar

R24h – Recordatório alimentar de 24 horas

SQUASH – *QUestionnaire to ASsess Health-enhancing physical activity*

SGBD – Sistema de gerenciamento de banco de dados

SQL – *Structured query language*

TIC – Tecnologia da informação e comunicação

UML – *Unified modelling language*

WHO – *World Health Organization*

1 INTRODUÇÃO

O estilo de vida atual tem exercido efeitos deletérios na saúde das populações. O papel da alimentação inadequada, inatividade física, tabagismo, estresse psicossocial, poluição, baixo acesso aos serviços de saúde, dentre outros fatores, desperta grande interesse por parte da sociedade científica e autoridades governamentais. Análises do modo como estes atuam no desenvolvimento de doenças, sob a ótica de diferentes áreas, ancoradas em estudos epidemiológicos, são relevantes, podendo orientar intervenções e auxiliar na formulação de políticas públicas. Em países desenvolvidos e emergentes, é notório que a dieta tem se afastado dos padrões recomendados pela Organização Mundial de Saúde – OMS (WHO, 2004). Considerando o papel relevante da nutrição na prevenção de doenças crônicas não-transmissíveis (DCNTs), é desejável aprofundar o conhecimento sobre os efeitos da alimentação desde etapas muito precoces da vida.

O Brasil vivenciou a transição nutricional, marcado pela queda acentuada da desnutrição, acompanhada de crescentes cifras de obesidade. Esta situação tem sido atribuída, em grande parte, à alta densidade energética da alimentação associada ao consumo de alimentos processados e ultraprocessados em detrimento dos *in natura* (IBGE, 2010). Como consequência, ocorreu a transição epidemiológica, sendo hoje as DCNTs nossos principais problemas de saúde pública (WHO, 2004). As tendências temporais revelam a gravidade do excesso de peso, principal fator de risco para as doenças que mais acarretam a morte dos brasileiros (BATISTA FILHO e RISSIN, 2003).

Por um lado, a adiposidade excessiva, especialmente abdominal, desencadeia mecanismos envolvidos na gênese de doenças como diabetes mellitus tipo 2, hipertensão arterial, dislipidemias, doença cardiovascular e câncer (WHO, 2004, 2009; MAGNUSSEN et al., 2012; REUVEN et al., 2016; BRAY et al., 2013; MALIK et al., 2013; HANSON e GLUCKMAN, 2015). Por outro, há evidências de que o quadro de morbimortalidade pode ser atenuado, ou mesmo prevenido, com a aquisição de conhecimentos e habilidades em nutrição gerando mudanças nos hábitos alimentares (CARBONE e ZOELLNER JM, 2012; WHO, 2013; TABBAKH e FREELAND-GRAVES, 2016). Lacunas no conhecimento nesta área têm, há décadas, motivado pesquisas no campo da epidemiologia nutricional. Nesse sentido, experiências estrangeiras de coortes de profissionais da saúde têm contribuído para identificação de determinantes de DCNTs e de seus mecanismos, bem como para proposição

de meios de controle (COLDITZ e HANKINSON, 2005; WILSON et al., 2012).

O *Nurses' Health Study* – NHS (http://www.channing.harvard.edu/) tem trazido relevantes contribuições no entendimento do papel de hábitos de vida e medicamentos na saúde de enfermeiras americanas (COLDITZ e HANKINSON, 2005). As investigações iniciais se baseavam em questionários validados, com foco em câncer e efeitos crônicos dos contraceptivos orais (HU et al, 1997), sendo, ao longo do tempo, acrescentados outros desfechos e coletas laboratoriais (NHS 2 e 3). Além de resultados da coorte do NHS, análises tipo caso-controle também foram publicadas (TWOROGER et al., 2011). Na mesma linha, o *Health Professionals Follow-Up Study* – HPFS (http://hsph.harvard.edu/hpfs) tem buscado investigar aspectos da saúde do homem (WILSON et al., 2012).

O fato de se estudar profissionais da saúde pode, teoricamente, melhorar a adesão a estudos desta natureza. Em países em desenvolvimento, iniciativas semelhantes de se estudar profissionais da saúde são escassas. Em parte, isso se deve à complexidade logística, limitações de recursos humanos e altos custos envolvidos na coleta e análise dos dados. Além disso, a ausência de instrumentos validados e reprodutíveis localmente, que possibilitem medições com segurança e precisão, consiste numa das maiores dificuldades enfrentadas no estudo da relação saúde-doença (FISBERG et al., 2009).

Avanços tecnológicos têm facilitado a obtenção de dados de forma mais ágil e padronizada. O preenchimento eletrônico dos dados pode, entre outras vantagens, garantir imediata construção de um banco de dados (BD), além de reduzir custos, erros, vieses e duplicidade de informações. Questionários eletrônicos podem ser autopreenchidos e a qualidade da informação assim obtida pode ser aprimorada quando os participantes são dotados de conhecimentos sobre o tema de interesse para a pesquisa.

Nicho interessante de pesquisa no nosso meio sobre o papel de hábitos de vida na saúde, em especial no que diz respeito à alimentação, são os nutricionistas. É possível especular também que estudantes de cursos de Nutrição possam alterar seus hábitos alimentares à medida que adquiram conhecimentos específicos sobre a importância da nutrição para prevenção de agravos à saúde. Dessa forma, vislumbra-se nestes estudantes e em nutricionistas uma fonte notável e oportuna de investigações sobre determinantes ambientais de doenças, especialmente aquelas relacionadas à adiposidade corporal. Tendo isso em mente, origina-se o ***Nutritionists' Health Study* – NutriHS** no nosso meio, por iniciativa de pesquisadores da FSP-USP (www.fsp.usp.br/nutrihs).

Considerando-se a duração dos cursos de graduação, a contínua admissão de novos alunos, a possibilidade de acompanhar os recém-graduados e, ainda, a viabilidade de se resgatar dados de egressos, abrem oportunidade ímpar da criação de uma coorte de estudantes e egressos de curso de Nutrição. Convites a pesquisadores de outros centros universitários que oferecem graduação em Nutrição permitem ampliação da amostra original do NutriHS. Com suas características metodológicas, é promissor também por incluir indivíduos jovens, permitindo acompanhamento por longo período a ocorrência de desfechos (coorte) e auxiliando na investigação sobre a importância de fatores nutricionais de risco ou proteção para DCNTs, bem como de novos fatores ou marcadores pouco explorados na literatura.

Deter conhecimentos e habilidades na área de nutrição é relevante considerando a complexidade dos instrumentos específicos e da avaliação de dados em saúde. A escolha de estudantes de Nutrição e nutricionistas deveria facilitar a obtenção de dados de qualidade. Avaliação do estado nutricional pode ocorrer por diferentes métodos, devendo ser a escolha baseada no instrumento que melhor detecte o problema em estudo ou aqueles para os quais os pesquisadores tenham maior treinamento técnico.

1.1 AVALIAÇÃO DE DADOS EM SAÚDE: ALIMENTAÇÃO E ATIVIDADE FÍSICA

Alimentação inadequada e sedentarismo influenciam diretamente o estado nutricional. Frente ao reconhecido papel na gênese da obesidade estão entre os dados em saúde mais estudados. A exposição a estes fatores de risco tem sido avaliada por métodos diversos, buscando entender seus desfechos ao longo do tempo. A escolha do método está na dependência da finalidade da investigação, disponibilidade de recursos, características da amostra, dentre outros fatores.

Métodos acurados de avaliação da dieta e do gasto energético, devido à complexidade operacional e custo, são pouco aplicáveis a estudos epidemiológicos. Grande parte das evidências relacionando alimentos e nutrientes ao risco de DCNTs se baseia em dados coletados por inquéritos alimentares. Entretanto, a aplicação destes métodos demanda tempo para treinamento, coleta, conferência e digitação de dados. Como pesquisas em epidemiologia nutricional embasam ações em saúde pública, a qualidade da informação é fundamental, devendo os instrumentos de avaliação dietética ser de fácil aplicação e com adequada relação

custo-benefício. A estimativa do consumo alimentar sofre variações decorrentes do próprio processo de avaliação, desde a obtenção das informações relatadas até a compilação dos dados. Dentre os métodos de avaliação da dieta mais usados estão os recordatórios de 24 horas (R24h), diários e os questionários de frequência alimentar (QFA) (VOSS et al., 1998; FISBERG et al., 2009; FERRI et al., 2013).

O R24h consiste em quantificar e definir todos os alimentos e bebidas consumidas pelo entrevistado nas últimas 24 horas. O diário difere do R24h pelo fato de ser preenchido pelo próprio indivíduo que consumiu a dieta. Por serem métodos que descrevem uma grande variedade de alimentos, são usados quando se deseja avaliar a média da ingestão de nutrientes e energia. A memória pode subestimar o consumo ou pode haver uma ingestão atípica, não representando a rotina alimentar. Buscando maior abrangência e menor viés de memória, o R24h deve ser aplicado mais de uma vez. Sua complexidade limita seu uso em pesquisas de grande porte. O QFA tem estrutura fixa com questões pré-determinadas, possibilitando estimar a ingestão habitual. Devem ser validados para população em estudo. Sua mais importante limitação é a memória para relatar o consumo alimentar de passado mais distante.

A atividade física também é elemento chave para o equilíbrio energético e manutenção do peso corporal (KATZMARZYK e LEAR, 2012; BALK et al., 2015; RICCARDI et al., 2016; CLAAS e ARNETT, 2016). Recentes metanálises sugerem que existe uma associação linear entre atividade física e risco de insuficiência cardíaca e diabetes tipo 2 na população em geral (AUNE et al., 2015; PANDEY et al., 2015). Seu papel protetor contra diversas DCNTs está consagrado e as recomendações internacionais são de prática de 30 minutos de atividade física moderada na maior parte dos dias da semana (HASKELL et al., 2007).

Apesar de existirem métodos precisos de avaliação do condicionamento físico de indivíduos, o nível de atividade física em populações é comumente investigado por meio de questionários. Diante do grande número descrito, especialistas propuseram o questionário internacional de atividade física (IPAQ) (CRAIG et al., 2003) (www.ipaq.ki.se/scoring.pdf), que permite a comparação dos achados entre os estudos. O IPAQ tem uma estrutura padronizada e pode ser autopreenchido. No Brasil, estão disponíveis estudos de reprodutibilidade e de validação (PARDINI et al, 2001; MATSUDO et al., 2001).

Além de dificuldades inerentes às coletas de dados em papel, outros fatores limitam a pesquisa tradicional com entrevistadores, tais como o alto custo, treinamento, duração e viés de respostas socialmente aceitas. Para aumentar a eficiência e melhorar a qualidade da informação,

pesquisas internacionais têm enfatizado o uso de sistemas computadorizados com autopreenchimento (RUSSELL et al., 2010; HERCBERG et al., 2010; ILLNER et al., 2012; HERCBERG, 2012; FERRI et al., 2013; VAN GELDER et al., 2013). De fato, os dois dos instrumentos mais frequentemente usados para avaliar hábitos de vida de populações, QFA e IPAQ, são dotados de uma estrutura fixa que viabiliza seu preenchimento por meio eletrônico.

1.2 INFORMÁTICA NAS INVESTIGAÇÕES EM SAÚDE

Pesquisas de grande porte em saúde, particularmente aquelas em epidemiologia nutricional, necessitam de instrumentos eficazes e precisos para obtenção de informações sobre o estilo de vida de populações. A aplicação de técnicas computadorizadas que efetuem, controlem e corrijam processos, sem a interferência do homem tornou-se um diferencial competitivo em diversas organizações ou empresas. A evolução tecnológica mundial atinge praticamente todas as atividades e favorece a veiculação livre e rápida de grande volume de informações por diversos meios, principalmente pela Internet. Tal modernização pode ser entendida como o esforço para transformar as tarefas manuais repetitivas em processos realizados por máquinas. Erros que antes eram cometidos por falhas de cálculos passam a ser quase nulos. Organizações ou empresas dedicam-se menos a atividades contínuas e repetitivas e focalizam mais em seu objetivo. De forma semelhante, ensino e pesquisa em ambiente universitário também têm se beneficiado da informática.

As ciências da informática lidam com a informação, organizando-a e classificando-a de modo a permitir tomada de decisão frente a objetivos. O ramo denominado tecnologia da informação e comunicação (TIC) dedica-se a um conjunto de atividades e recursos de computação que buscam a produção, armazenamento, transmissão, acesso e o uso das informações. Envolve os conceitos de processamento de dados, sistemas de informação, engenharia de *software*, informática e *hardware*, aplicados para fins administrativos e organizacionais (EATON e STRUTHERS, 2002; PEREZ et al., 2010).

Para usufruir das facilidades da TIC um passo inicial é o desenvolvimento de um sistema ou programa que entenda as necessidades dos usuários e as transforme em um produto, o *software* (DA ROCHA et al., 2001). A evolução nesta área ocorreu frente à padronização de técnicas eficientes que melhoraram a qualidade e agilidade dos processos de desenvolvimento (HOLDEN e KARSH, 2010).

A popularização dos microcomputadores, dos sistemas informatizados e de rede e a era da Internet permitiram a consolidação da TIC em diversas áreas, em especial na saúde. Hoje, a TIC tem permitido atuações mais seguras, acessíveis e eficientes no que se refere aos cuidados em saúde. Também considerando eficiência econômica e controle dos custos, a introdução desta tecnologia teve impacto bastante favorável (RUSSELL et al., 2010; HERCBERG et al., 2010; WEBB et al., 2010; ILLNER et al., 2012; HERCBERG, 2012; FERRI et al., 2013; VAN GELDER et al., 2013). Nas organizações de saúde, a repercussão desta tecnologia foi tão ampla que desafiou a competência focada apenas no conhecimento de um único profissional. A introdução de novas técnicas e equipamentos favoreceu a interação entre membros de equipes multidisciplinares. O diagnóstico ou tratamento de pacientes por diversos profissionais da saúde pode, atualmente, envolver interações a distância, como ocorre na telemedicina (ZAPATA et al., 2016; KASSAR et al., 2016).

Em qualquer campo de atuação, informação e conhecimento de qualidade, bem como gerenciamento destas informações, são de suma importância, uma vez que o uso inadequado destes pode levar a erros de análise e conclusões equivocadas (CALLEGARO et al., 2015). No setor da saúde, aplicativos destinados à coleta eficiente e acurada de dados, estão sendo demandados como uma forma de acelerar o conhecimento a ser revertido em prática.

1.3 RELEVÂNCIA DO DESENVOLVIMENTO DE SOFTWARE EM EPIDEMIOLOGIA NUTRICIONAL COMO NO NUTRIHS

O estabelecimento do NutriHS representou marco importante na obtenção de dados relacionados à nutrição em grande quantidade e com alta qualidade. O universo amostral de futuros nutricionistas acrescidos dos egressos de cursos de Nutrição abre uma janela de oportunidades na investigação de determinantes de doenças em estratos específicos, à semelhança do que vem ocorrendo em coortes do Primeiro Mundo, destacando-se o NHS e HPFS (COLDITZ e HANKINSON, 2005; WILSON et al., 2012).

O NHS (http://www.channing.harvard.edu/nhs/) incluiu 238.000 enfermeiras, enquanto o HPFS (http://www.hsph.harvard.edu/hpfs/) 51.529 profissionais da saúde do sexo masculino. Estas populações foram selecionadas em função do nível educacional, que reverte em alto grau de precisão na resposta a questionários tecnicamente formulados, além da suposição de que estes profissionais seriam motivados à participação em estudos desta natureza. Por se tratar de

estudos idealizados há décadas, na concepção não estavam disponíveis meios mais ágeis e menos dispendiosos para obtenção de dados.

Para estudos de grande porte em epidemiologia nutricional é desejável a existência de ferramentas amigáveis que melhorem a adesão dos participantes e a fidedignidade dos dados obtidos. Sistemas informatizados têm cumprido este papel em numerosas esferas profissionais e na pesquisa, agilizando a construção e a qualidade do BD. Esta tecnologia já vem sendo empregada em nutrição, no campo do *e-learning* e dos *softwares* para digitação de questionários estruturados. Contudo, estes sistemas não servem para coleta *on-line* dos dados.

Considerando-se apenas a análise de dieta, alguns exemplos são encontrados no Brasil e noutras regiões do mundo. Um *software* para informatização do R24h foi desenvolvido como instrumento de calibração pela *International Agency for Research of Cancer*, em colaboração com centros do *European Prospective Investigation Into Cancer*, o EPIC-SOFT (VOSS et al., 1998). Este possibilita codificação de produtos alimentares e ingredientes da receita, bem como cálculo da ingestão de nutrientes. Na mesma linha, o *National Cancer Institute* desenvolveu o *Automated Self-Administered 24-Hour Recall* (ASA 24), resultando em R24h computadorizado, totalmente codificado e ligado a BD de nutrientes. O ASA 24 (http://riskfactor.cancer.gov/tools/instruments/asa24/) consiste em um *website* usado para coletar dados de consumo autopreenchidos por participantes de pesquisas, com acesso remoto do pesquisador para gerenciar o estudo. No Brasil, três sistemas *on-line* de monitoramento de dieta estão disponíveis, sendo que nenhum é totalmente autoadministrado. Dois deles são voltados para coleta de dados de saúde de escolares, o NutriSim (FERRI et al., 2013) e o CAAFE (Consumo Alimentar e Atividade Física de Escolares) (DA COSTA et al., 2013), e o terceiro, NutriQuanti (http://www.nutriquanti.com.br/), para acompanhamento nutricional de adultos.

Nas últimas décadas, houve aumento no emprego de tecnologias de inovação para análise do consumo alimentar. Contudo, em epidemiologia nutricional, na qual é desejável um sistema mais flexível para englobar a coleta de dados multidisciplinares e múltiplos objetivos, seu uso é limitado. A informatização da coleta e do processamento de dados incorporada a estudos em andamento poderia trazer limitações quanto à comparabilidade com dados previamente obtidos em papel.

Recentes avanços tecnológicos proporcionaram melhorias na área de informática, tornando as ferramentas mais ágeis, amigáveis e confiáveis, associadas a menores custos e

erros, motivando a utilização de sistemas informatizados em estudos epidemiológicos. Alguns sistemas informatizados com questionários *on-line*, especificamente concebidos para desempenhar este papel, são encontrados na literatura, como no NHS e do HPFS em suas fases mais recentes. No entanto, não está disponível uma revisão sistemática sobre questionários *on-line* com esta finalidade.

As vantagens da informatização para coleta de dados em grandes pesquisas motivaram a desenvolvimento de um sistema baseado na *web* para o NutriHS. Instrumentos para coleta de dados *on-line*, com ampla aplicação em pesquisas epidemiológicas, permitindo obtenção de dados multidisciplinares, são raros ou inexistentes.

1.4 APLICANDO UM SISTEMA INFORMATIZADO NO NUTRIHS

Na relação entre estilo de vida e saúde encontra-se o melhor caminho para se reduzir o risco de DCNTs em saúde pública. O acompanhamento de desfechos ao longo do tempo e a busca de associações com hábitos alimentares, atividade física, estresse, dentre outros, contribui sobremaneira para possível identificação de fatores de risco modificáveis. A partir do entendimento da fisiopatogênese de doenças decorrentes destes fatores torna-se possível instituir medidas preventivas.

O nutricionista detém o conhecimento sobre o papel de nutrientes na saúde e na doença e está habilitado a orientar a alimentação de indivíduos. Na sua formação profissional, o aluno de Nutrição acrescenta gradualmente conhecimentos específicos, ao mesmo tempo que surgem como sujeitos de ações educativas. A educação nutricional desenvolvida durante a graduação passa a ser estímulo à sua transformação, com consequências marcantes na sua prática futura (CERVATO et al., 2005). Nesse sentido, acompanhar alunos de Nutrição durante sua graduação representa oportunidade para compreender a influência de sua formação em seus hábitos de vida. Considerando as características metodológicas do NutriHS, este possibilitará conhecer como a aquisição de conhecimentos interfere no estilo de vida, que influenciará desfechos ao longo da vida. Como também, abre-se a perspectiva de se estudar prospectivamente fatores de risco emergentes para DCNTs.

A educação nutricional na universidade representa importante meio para promoção da saúde. Qualquer experiência de ensino desenvolvida para facilitar a adoção voluntária de comportamento alimentar ou outro relacionado à nutrição, com a finalidade de conduzir à situação de saúde e bem-estar, pode ser encarada como educação nutricional.

São raras as publicações que avaliaram o impacto da aquisição de conhecimentos em Nutrição ao longo do curso universitário. Estão disponíveis estudos que comparam indivíduos expostos ou não a programas de reeducação alimentar, revelando melhor qualidade da dieta dos expostos comparados àqueles sem acompanhamento nutricional (PODDAR et al., 2010; CARBONE e ZOELLNER, 2012; WHO, 2013; TABBAKH e FREELAND-GRAVES, 2016). Apesar de bem estabelecidas as vantagens da educação nutricional para a promoção da saúde individual e coletiva, a adoção de hábitos alimentares saudáveis representa grande desafio para a saúde pública. Mudar hábitos e tradições da história individual, da família ou do grupo social é complexo, mas tal responsabilidade deve ser assumida durante a graduação em Nutrição.

O primeiro passo para que o nutricionista exerça tal papel é a mudança de seus próprios hábitos. Há a expectativa de que a aquisição de conhecimento e habilidades desenvolvidas no curso, voltados para a conscientização da importância da adoção de hábitos saudáveis, reverta em comportamentos mais saudáveis a começar pelos próprios.

2 JUSTIFICATIVA E HIPÓTESE

Este estudo justifica-se pela escassez de instrumentos para coleta de dados *on-line*, com ampla aplicação em pesquisas epidemiológicas, permitindo obtenção de dados multidisciplinares. O desenvolvimento de um sistema informatizado de coleta de dados tem o potencial de conferir agilidade e precisão em fornecer respostas a questões relevantes da saúde pública, como aquelas relacionadas ao estado nutricional de populações e fatores de risco.

O NutriHS foi concebido lançando mão de TIC para criação do ***e*-NutriHS**. A descrição das etapas de sua criação merece ser compartilhada, considerando que uma experiência bem sucedida deva ser copiada em outros campos do conhecimento científico.

A aplicação de um novo sistema informatizado, a sua capacidade de testar hipóteses de pesquisa e a habilidade de produzir resultados de qualidade necessitam ser asseguradas.

Uma hipótese do presente estudo é a de que a evolução dos conhecimentos em Nutrição impacta favoravelmente não apenas na qualidade da informação, mas também em parâmetros indicativos de uma alimentação saudável (dietéticos e antropométricos).

A inclusão de futuros e atuais nutricionistas favorece a obtenção de informações de qualidade sobre saúde e dieta e, talvez, maior adesão a exames subsidiários.

Considerando-se a contínua admissão de graduandos e as possibilidades de seguir egressos, prevê-se a criação da coorte de alunos e ex-alunos de cursos de graduação em Nutrição, que possibilitará análises de desfechos, auxiliando na compreensão de fatores de risco, ou proteção, nutricionais para DCNTs.

3 OBJETIVOS

3.1 GERAL

Por meio da criação de sistema computadorizado, o *e*-NutriHS, objetiva-se examinar sua aplicação no NutriHS na avaliação da relação entre aquisição de conhecimento em Nutrição com hábitos dietéticos e medidas corporais em estudantes e egressos de cursos de Nutrição.

3.2 ESPECÍFICOS

1. Analisar criticamente *softwares* internacionalmente disponíveis, voltados à coleta e análise de dados sobre nutrição e alimentação (**Artigo 1**);
2. Desenvolver e implementar o sistema *web*, juntamente com seu BD, para acesso remoto dos participantes do NutriHS para responderem a conteúdos de interesse (**Artigos 2 e 3**);
3. Elaborar a documentação do sistema *web*, visando a captar os requisitos necessários para o seu desenvolvimento (**Anexo 1 e Artigo 2**);
4. Proceder a validação os dados coletados pelo sistema do NutriHS (**Artigos 2 e 4**);
5. Comparar hábitos de vida (dieta e atividade física), medidas antropométricas e perfil bioquímico de estudantes de Nutrição em diferentes períodos do curso e de nutricionistas (**Artigo 5**).

4 MATERIAL E MÉTODOS

O material deste estudo refere-se àquele necessário para desenvolver o instrumento de coleta de dados, bem como aos indivíduos que se utilizaram deste para fornecimento de seus dados. Assim, este tópico encontra-se dividido em duas partes, o desenvolvimento do instrumento e a sua aplicação.

4.1 DESENVOLVIMENTO DO INSTRUMENTO

Para atender aos objetivos específicos de 2 a 5, o material empregado refere-se aos equipamentos de informática disponíveis na Instituição. Para desenvolvimento do instrumento computadorizado da pesquisa, algumas etapas foram cumpridas até se chegar ao produto final, o sistema *web*, utilizado pelos participantes. Maiores detalhes podem ser encontrados na documentação dos questionários *on-line* contida no Anexo 1.

- ***Levantamento dos requisitos***

Nesta etapa houve a definição das propriedades e funções necessárias ao desenvolvimento do projeto. Compreendeu a revisão do problema e necessidades dos pesquisadores que se utilizam o sistema. Os requisitos foram devidamente documentados e modelados no padrão *Unified Modelling Language* (UML), linguagem específica de sistemas computacionais, por meio de orientação a objetos. A UML é um modo de padronizar a modelagem, permitindo especificação, documentação, estruturação para sub-visualização e maior visualização lógica do desenvolvimento completo do sistema, tornando-o mais claro e confiável.

- ***Modelagem do BD***

O BD foi construído em Linguagem de Consulta Estruturada (*Structured Query Language* – SQL). Esta linguagem é a padrão universal para se programar BD e foi empregada por meio do sistema de gerenciamento de banco de dados (SGBD) MySQL (ORACLE© 2012, Oracle Corporation and/or its affiliates), por ser o preconizado na FSP/USP. Além disso, trata-se de uma linguagem livre, de fácil uso e de bom desempenho e estabilidade.

- ***Programação e desenvolvimento do software***

O *e*-NutriHS foi composto por um *website* com integração ao BD, visando ao preenchimento dos questionários (socioeconômico, demográfico, de hábitos de vida, antecedentes mórbidos pessoais e familiares e questionários de frequência alimentar e de atividade física), disponibilizados por senha individual para acesso remoto pelos participantes. Este sistema contém um *link* para agendamento das coletas de dados clínicos e laboratoriais. Os dados referentes às coletas presenciais são inseridos pelo pesquisador. As interfaces do participante, pesquisador e administrador foram feitas em *HyperText Markup Language* – linguagem de Marcação de Hipertexto (HTML), *Cascading Style Sheets* (CSS) e *JavaScript*, compatíveis com os navegadores comerciais (Internet Explorer®, Google Chrome®, dentre outros); estas são as três das principais tecnologias para a construção de páginas da *web*. Este *site* contém programação baseada em *Personal Home Page* (PHP), que é uma linguagem de *script open source* de uso geral, muito empregada para desenvolvimento de aplicações *web*, embutida no HTML, usada originalmente apenas para o desenvolvimento de aplicações presentes e atuantes no lado do servidor, capazes de gerar conteúdo dinâmico na Internet.

- ***Testes***

Esta etapa consistiu na implementação do sistema em amostra de voluntários para verificação da programação e facilidade de uso. Tais voluntários preencheram todos os questionários contidos no sistema *web*. Ao finalizar o teste, opinaram sobre a facilidade de uso, amigabilidade da interface e satisfação quanto ao sistema. Em um segundo momento, estes indivíduos responderam os mesmos questionários coletados por *e-mail* para avaliar a compatibilidade dos resultados.

Com base em experiências prévias (NIELSEN e LANDAUER, 1993) que revelaram que cinco usuários bastam para se descobrir a grande maioria dos problemas relacionados ao sistema, foram convidados de 18 voluntários adultos de ambos os sexos para testar o sistema *web*. Estes voluntários não haviam participado de nenhuma etapa da programação dos *softwares* do NutriHS. A concordância entre dados obtidos em papel com aqueles coletados eletronicamente foi testada pela estatística kappa e o coeficiente de correlação interclasse com resultados idênticos.

4.2 APLICAÇÃO DO E-NUTRIHS

O universo amostral da primeira fase do NutriHS está sendo constituído com todos os voluntários que se registraram no sistema a partir de 1º de março de 2014 até 1º de dezembro

de 2016, não existindo critérios de exclusão, exceto gestação. Aqueles que no momento da coleta de materiais biológicos apresentaram sinais e sintomas de doenças agudas tiveram os procedimentos postergados até a resolução do processo. Todos que aceitaram participar foram esclarecidos dos propósitos do NutriHS e assinaram eletronicamente o termo de consentimento livre e esclarecido (Anexo 2). Os procedimentos seguem as normas do Conselho Nacional de Saúde, no que se refere à ética em pesquisa com seres humanos. O projeto foi aprovado pelo Comitê de Ética da FSP/USP (CAAE 12455313.8.0000.5421) (Anexo 3).

O delineamento foi transversal e incluiu os dados da linha de base do NutriHS. Os voluntários que concordaram em participar responderam eletronicamente a questionários relativos a dados socioeconômicos, dietéticos e atividade física e agendaram eletronicamente visita ao Centro de Saúde Escola da FSP/USP. Neste momento, foram submetidos a exame físico, com obtenção de medidas antropométricas e pressão arterial e coleta de sangue para diversas determinações.

- ***Coleta de dados clínicos***

O peso tem sido obtido em balança digital com capacidade de 150 kg e precisão de 100 g e a altura com precisão de 0,5 cm. A partir destas medidas foi determinado o índice de massa corporal, sendo usada a classificação da Organização Mundial da Saúde para classificar o estado nutricional (WHO, 2000). A circunferência da cintura tem sido obtida no ponto médio entre a última costela e a crista ilíaca, com fita inelástica flexível e com precisão 1,0 mm.

Para obtenção da composição corporal está sendo utilizado o densitômetro de dupla emissão com fonte de raio-X (iDXA/GE LUNAR®).

A pressão arterial tem sido obtida três vezes por meio de aparelho automático (Omron model HEM-712C, Omron Health Care, Inc, USA), com adequação do manguito à circunferência braquial. Os valores finais de pressão sistólica e diastólica (em mmHg) são as médias aritméticas das duas últimas medidas.

- ***Avaliação da ingestão alimentar***

A avaliação dos hábitos alimentares tem sido realizada por meio de QFA validado (FISBERG et al., 2008). Os dados autorreferidos coletados através do *e*-NutriHS são imediatamente transformados, com base no banco de dados de alimentos e nutrientes do USDA *National Nutrient Database for Standard Reference* (USDA, 2016), em consumo diário de macro e micronutrientes e grupos de alimentos.

Para minimizar a variação interindividual e como recomendado pelo Health *Eating Index Technical Report* (GUENTHER et al, 2007; GUENTHER et al., 2013), os nutrientes são ajustados para 1.000 kcal. O número diário de porções de cada grupo de alimentos foi então calculado com base nas recomendações do HEI-2010 (GUENTHER et al., 2013). A elaboração de HEI e a definição de pontos de corte para a pontuação máxima, intermediária e mínima para cada componente foi baseada nas recomendações do HEI-2010 (GUENTHER et al., 2013), OMS (WHO, 2004) e da Sociedade Brasileira de Cardiologia (SANTOS et al., 2013).

- ***Avaliação da atividade física***

A avaliação da atividade física tem sido realizada por meio do IPAQ, versão curta, disponibilizado *on-line* (CRAIG et al., 2003), previamente validado (PARDINI et al., 2001; MATSUDO et al., 2001).

4.3 ANÁLISE ESTATÍSTICA

Os dados coletados estão sendo armazenados no BD do NutriHS. Para fins desta tese o BD foi fechado em 1º de março de 2016.

Detalhamento da análise estatística dos artigos que compõem esta tese está fornecido em cada um deles. A revisão sistemática seguiu as recomendações internacionais para estudos observacionais (STROUP et al., 2000) e seus resultados foram compilados em tabelas.

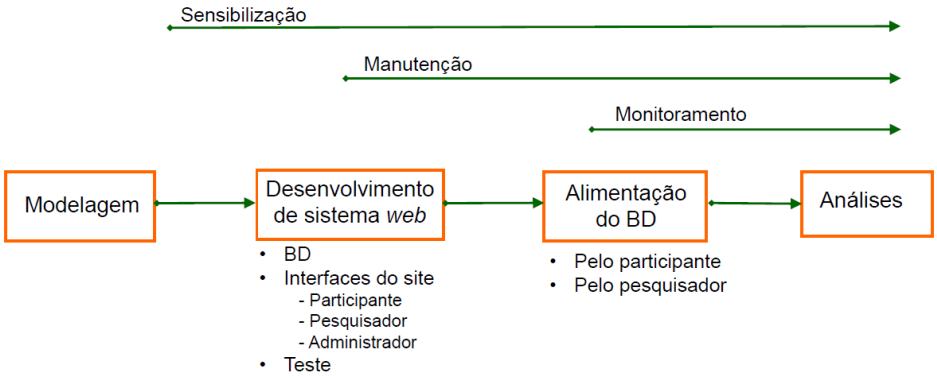
Em geral, os dados dos participantes estão expressos em média e desvio-padrão. Para as variáveis que não tiveram distribuição normal foi feita transformação matemática ou utilizado teste não paramétrico. Os dados dietéticos foram expressos em porções, gramas ou como porcentual do valor calórico total. Os resultados de atividade física foram apresentados em minutos por semana.

Teste *t* de Student e ANOVA (ou correspondente teste não-paramétrico) foram usados para comparar médias. Variáveis categóricas foram comparadas pelo teste do qui-quadrado. Para as análises de validação dos dados antropométricos, foram calculadas as diferenças entre os valores autorrelatados e aferidos, a correlação (coeficiente de Pearson) e a concordância (estatística Kappa) complementada pela análise de Bland-Altman. O nível de significância foi fixado em $p < 0,05$. A análise foi realizada com o auxílio do SPSS®, versão 22.0 para Windows.

5 AÇÕES INICIAIS

Na idealização do NutriHS, fez-se necessária a reflexão sobre as suas principais etapas e passos fundamentais para garantir sua execução, resumidos na Figura 1.

Figura 1. Etapas da implantação do NutriHS.



Foram criados logotipo e *slogan*, usados nas divulgações do NutriHS. Na criação do logotipo refletiu-se sobre a escolha das cores. Cores causam impacto na vida humana e, ainda que imperceptivelmente, influenciam o comportamento físico, mental e emocional (FARINA, 1982). Na seleção de cores do NutriHS, partiu-se do pressuposto que o logotipo colorido (Figura 2) teria capacidade de captar rapidamente a atenção dos indivíduos, facilitando a memorização de mensagens e construindo uma linguagem eficaz de comunicação.

Figura 2. Logotipo do NutriHS.

Em publicidade, a cor laranja é considerada chamativa e motivadora enquanto o verde oferece sensação calmante (FARINA, 1982). O laranja representa a jovialidade e o verde a representação de natureza e saúde. Diante faixa etária dos participantes do NutriHS, estas cores foram selecionadas para o logotipo, usado no *layout* do *site* e na rede social de relacionamentos.

A marca e o logotipo passaram a ser instrumentos de identidade, servindo para atrair usuários. Na mesma linha, criou-se o *slogan* “Conhecendo nutrição, gerando saúde” que resume os objetivos principais do estudo.

Para ampliar a divulgação e incrementar a adesão foi criada uma página no *Facebook* (Figura 3), que é um elemento onipresente na vida da população mundial e, como tal, com potencial de impactar em práticas sociais em ambientes acadêmicos, profissionais e pessoais. Para o NutriHS, a página também foi criada para estimular o vínculo com os participantes, tornando mais prazerosa sua participação (https://www.facebook.com/nutrihs). Esta página tem atualizações semanais com notícias do estudo, resumos de artigos científicos de interesse, divulgação de eventos, dentre outros.

Figura 3. Layout da página do *Facebook* do NutriHS.

Em paralelo, foi desenvolvido o *site* institucional para atingir o objetivo da coleta dos dados, disponibilizado no endereço http://www.fsp.usp.br/nutrihs/ (Anexo 1).

6 RESULTADOS

ARTIGO 1

Comparative analysis of Web-based surveys in nutritional epidemiology: a systematic review

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ABSTRACT

The assessment of lifestyle factors, as diet and physical activity, and others possible risk factors in large samples is essential for preventing chronic disease, but knowledge about the merits of innovative technologies to deal with from data gathering to analysis, in nutritional epidemiology is lacking. We analyzed Web-based surveys addressed to collect data on health aspects particularly related to the nutritional status in MEDLINE/PubMed, Cochrane Library, ScienceDirect, EMBASE, and WebSurveyMethodology, and by direct contacts with authors and/or study sites. Ten surveys provided information on diet and physical activity. In general, healthy volunteers were recruited to evaluate several hypotheses relating lifestyle to diverse outcomes. The studies included at least 1,120 participants (age at baseline: 20-40 years). They used food frequency questionnaire and different instruments to assess physical activity. Their strengths and limitations were related to their protocol, or to the computer and/or internet facilities. This systematic review indicates that this strategy is qualified for conducting research in nutritional epidemiology as well.

Key words: Web-based surveys; lifestyle; nutrition; nutritional epidemiology; Internet.

INTRODUCTION

The high prevalence of lifestyle-related morbidities, such as obesity, hypertension, and type 2 diabetes mellitus is a serious public health burden associated to complication and to high medical expenditures.[1-4] Epidemiological and clinical studies have contributed to identify modifiable risk factors and to deepen the understanding of the pathophysiology of non-communicable chronic diseases (NCCDs), such as type 2 diabetes mellitus and cardiovascular disease.[4-6] It is unquestionable that the assessment of dietary and other lifestyle factors is essential for preventing chronic disease, but knowledge about the merits of innovative technologies to deal with the entire process, from data gathering to analysis, in nutritional epidemiology is lacking. Therefore, the objective of this review was to analyze Web-based surveys addressed to collect data on health aspects particularly related to the nutritional status.

The assessment of data on lifestyle and possible risk factors is challenging as large samples are required to provide statistical power for reliable results. Furthermore, it is desirable that data be collected through repeated measures over a period of time.[7] Until recently, most surveys had used paper-and-pencil questionnaires distributed by mail. Response rates, as well as the quality

of the answers, are generally low, requiring additional efforts to contact participants to correct errors. In addition, the information needs to be digitalized and transferred to an electronic format to build the database (DB), a costly and time consuming effort.[3]

The use of information and communication technology in nutritional epidemiology is promising to overcome some of the logistical and financial feasibility constraints that can affect the conduct of large-scale surveys.[3,8-10] Furthermore, the continuous decline in information and technology-related costs and the increase in Internet speed have allowed the development of modern Web-based surveys.[8-10] In the last two decades, the number of internet users has increased tenfold.[11] The Web has introduced a number of advantages in survey research, such as the broad reach of geographic areas,[12-13] standardization of questionnaire administration eliminating interviewer-associated bias,[14] automated data entry, checking and storage collected in a format suitable for analysis, minimization of entry errors,[15] and feedback opportunities, enhancing participation rates.[12-14] However, some concerns about duplicate records by the same participant, low data quality and sampling issues of on-line surveys have been raised.[3,14,16] Most of these problems have can be solved technically, for example, the use of registration through individual username and password, the use of screening questions to detect duplicates, and checks for implausible answers.[3,8-10]

An increased number of articles using innovative assessment technologies have been published in public health literature, although their specific use in the nutritional epidemiology is limited.[8] Moreover, knowledge about the merits of innovative technologies to support research in nutritional epidemiology is lacking. Thus, the aim of this systematic review was to search and analyze Web-based surveys to determine the degree to which data collected on various health aspects related to the nutritional status are improved or compromised by using Web-based technologies.

METHODS

The search of literature for eligible studies used multiple strategies, mainly the computer-based search of library databases, supplementary search of the references included in the studies identified, and direct contacts with the corresponding author and/or the study site. Specifically, the electronic databases searched were MEDLINE/PubMed, Cochrane Library, ScienceDirect, and EMBASE. We also examined WebSurveyMethodology (www.websm.org), the main website dedicated to the methodological issues of Web surveys. Prior to applying eligibility criteria, the initial database search was based on a combination of the following key words: (1)

web, Internet, web-based, on-line; (2) questionnaire, survey, panel; and (3) epidemiology, lifestyle, e-cohort, e-epidemiology. Only studies written in English, Spanish, and Portuguese were included. Searches covered the period January 1980 to January 2016.

Studies were selected if they met the following criteria: (1) health-related issues; (2) handled through a dedicated website; (3) self-administered surveys; (4) prospective cohort design for individuals aged 18 years and older; (5) inclusion of multidisciplinary data regarding at least diet, physical activity, and nutritional status.

Any uncertainty related to the inclusion of articles was discussed with the authors. When several articles were based on the same sample and methods, within the same period of time, the most detailed report of the methods was included.

Main characteristics of the objectives, sample/population, and methods are described in tables 1 and 2, as well as comments on strengths and weakness in table 3.

RESULTS

A total of 1,774 articles were retrieved, of which 1,580 were excluded by their title, since they were not appropriate for the subject under study or because they were duplicated in the databases, leaving 194 records screened for abstract reading. From those abstracts, 74 articles were selected for full text reading. Ten cohort studies deal with multidisciplinary data, but two of them were conducted in children or adolescents.[17-18] Additionally, two Internet-based surveys, not retrieved through the databases, were found by their website, and they were included due to their relevance to nutritional epidemiology research (Figure 1). Therefore, 10 Web-based surveys met all the eligibility criteria and were considered in this systematic review.

The reviewed studies, in alphabetical order, are summarized on Table 1. Study designs included longitudinal observational surveys, with follow-up ranging from 15 weeks[19] to life-time observations. Only two studies have completed their follow-up[19-20] and four are still recruiting volunteers.[21-24] Of the 10 studies, health professionals were involved in four, the Health Professionals Follow-Up Study – HPFS,[25] the Nurses' Health Study III – NHS III,[21] the Nurses and Midwives e-cohort Study – NmeS,[26] and the Nutritionists' Health Study – NutriHS.[22] Three studies, the Early Life Factors Study – ELF,[20] Nascita e INFanzia gli Effetti dell'Ambiente – NINFEA,[27] and PRegnancy and Infant Development – PRIDE[24] are following mothers and children from pregnancy and three are adult cohorts, the Black Women's Health Study – BWHS,[28] the Lifestyle and Immune Function Study – LIME,[19] and NutriNet-Santé Study.[23]

The studies include large sample sizes with at least 1,120 participants. The age at baseline ranged from 20 to 40 years, except for one study in which participants were older than 40 years[25] and three birth cohorts that recruited women older than 18 years as well as newborns.[20,24,27] Studies were conducted in Europe (n = 4), North America (n = 3), Oceania (n = 2), and South America (n = 1). In general, studies recruited healthy volunteers to evaluate several hypotheses relating lifestyle factors to diverse outcomes.

The recruitment processes were heterogeneous. In three studies, invitations were sent to registered members of health professional boards and societies or health field students by regular mail,[21,25] e-mail,[21,26] by the study's website itself, or by word-of-mouth. The remaining studies used a variety of recruitment strategies, including a combination of personal visits, paper flyers, and specific websites and posts in social networks. The NutriHS also recruited volunteers through personal visits to university classrooms and events.[22] For the birth cohorts, advertisements through health care providers, healthcare websites, and/or dedicated to pregnant women, and forums on medical topics were used to recruit women that planned to be or are pregnant.[20,24,27] One study was based on a representative sample of the general population, invited via regular mail.[19] In the BWHS, invitations were mailed to subscribers of a magazine addressed to African-American women, members of African-American professional organizations, and friends of respondents.[28] A vast multimedia campaign (television, radio, national and regional newspapers, posters, and internet) called for volunteers in the NutriNet-Santé Study that targeted the general adult population.[23]

All surveys used self-reported questionnaires and some obtained biological samples (Table 2). Questionnaires included at least sociodemographic and clinical data, and medication history. Self-reported anthropometric measures were available for all studies; one was measured in a subsample[23] and another measured all the participants.[22]

All the studies used the food frequency questionnaire (FFQ), and five also had supplementary questions about dietary supplements and specific food habits.[21-25] The NutriNet-Santé study also used a 24-hour dietary record (24HR), filled three occasions during a 2-week period, as well as data on food storage and dietary habits, behavior and restrictions, knowledge of nutritional recommendations, and food preferences.[23]

Physical activity was assessed by the International Physical Activity Questionnaire (IPAQ)[29] in three studies[22-23,26]; three are using specific validated instruments for professionals[21,25] or for African Americans.[28] The LIME study[19] used the Danish Physical Activity Questionnaire (DPAQ),[30] which has been employed in Scandinavian countries. Few questions on physical

activity during pregnancy and of the child at age 10 years were obtained from the NINFEA.[27] In the ELF, the assessment was produced through five questions taken from the New Zealand Health Survey at the 2-year-old stage.[20] For the PRIDE study, an instrument developed by Dutch National Institute of Public Health and the Environment, the Short QUestionnaire to ASsess Health-enhancing physical activity (SQUASH)[31], was used to assess this aspect.[24]

Blood samples and other biological samples (urine, feces, or saliva) were collected in five studies.[21-25] In another study, only the saliva sample was collected.[27] Laboratory results were obtained from medical records in two studies.[24,28] In the remaining three studies, these data were not collected[19-20] or not available.[26] All studies include additional questionnaires addressing individual objectives.

Table 3 depicts limitations and strengths of the reviewed studies; some are related to the study protocol, while others to the computer and/or Internet facilities or intrinsic characteristics of self-reported data collection.

DISCUSSION

This systematic review of Web-based surveys, focused on nutritional status-related health concerns, was relevant to show that the use of technology to deal with data from its collection to analysis is scarce. Assessment of at least dietary and physical activity data is essential for research in nutritional epidemiology and for those with NCCDs prevention purposes. Despite an ample search, we were only able to select and analyze 10 studies. This scenario is in contrast to other knowledge fields, such as psychological and social research, which have commonly employed Internet-assisted surveys since the past century.[3] The heterogeneity of the studies represented an opportunity to disclose their pros and cons in order to improve further research in nutritional epidemiology.

The 10 Web-based studies included are heterogeneous with regards to several aspects, mainly concerning sample characteristics, recruitment type, and follow-up duration, although all of them had tested hypothesis linking lifestyle factors to health outcomes. The results of our review reinforced the fact that the Internet is a powerful tool, capable of reaching large samples, throughout wide geographic areas, of different sociodemographic levels and age ranges. We observed that the communication strategies used to recruit participants were quite different, and could be grouped into three main categories: on-line (social networks, website, forums, and e-mails), offline (phone calls, letters, flyers, banners), and face-to-face methods. The choice of the most adequate strategy depends on the population, Internet access, and resource availability.

Despite pronounced heterogeneity, all involved large sample sizes of more than 1,000 participants each, and collected self-reported data on sociodemographic status, lifestyle, and clinical history. As far as lifestyle is concerned, diet and physical activity are the most complex behaviors to be measured. An unavoidable limitation of instruments used to assess lifestyle aspects is that all information depends on the respondents' memory.

The FFQ was the most common instrument used to assess habitual diet; its main feature is that provides the probability of intake of most common food items and preparations over a preceding period of time, usually the prior year.[32] This is easy to be self-reported and the burden for the participant is relatively low. FFQs have been frequently employed in the cohorts involving health professionals,[4,21,25] due to the study aims and to the participants' abilities. Particularly in the NutriHS, in which the FFQ was developed and validated in a probability sample of Brazilian adults, the instrument also included serving sizes and their equivalents to household measurements in order to increase accuracy of the data collected.[33]

However, multiple instruments in the assessment of diet may be required when the main purpose is obtaining detailed information of diverse dietary exposures on nutrition-health outcomes. The 24HR has been used to express recent food consumption, and is useful to investigate response to interventions.[32] Respondents need to be trained before participating in the survey. This has been the main instrument used in the NutriNet-Santé Study, combined with a FFQ and questions about food storage and dietary habits, behavior and restrictions, knowledge of nutritional recommendations, food preferences, among others.[23] Despite the potentialities, the complexity of such a protocol would imply a heavy logistic burden and cost, which would make the study infeasible without using Web-based facilities. Using the Internet, the NutriNet-Santé Study enabled to conduct an important, large sample, international prospective study.

Additional data on the importance of nutrients' intake to health concerns are related to dietary supplements, whose prescriptions have been increasing for a number of preventive and therapeutic purposes. Electronic tools may easily collect quantitative data on these manufactured products. We verified that several reviewed studies obtained these data,[21-25] including those conducted in pregnant women and their children,[24] where the accuracy may be even better.

Another important exposure affecting the risk of outcomes is physical activity. The assessment of these data concurrently to dietary information is necessary for an adequate interpretation of the impact of nutritional status and/or lifestyle interventions on health. Since several instruments are standardized and were conceived to be self-reported, electronic responses are

facilitated. The IPAQ is the most common instrument used to assess physical activity level in the reviewed studies.[22-23,26] This is recommended by the World Health Organization to ensure data comparability and to facilitate the development of an international database on health-related physical activity.[29] Some studies' protocols have a disadvantage of having been established before the WHO recommendation. Therefore, the BWHS, HPFS, and NHS designed their own questionnaire that was further validated.[21,25,28] The SQUASH, applied in PRIDE, is a short questionnaire that assess habitual physical activity calculated by approximately the same domains of IPAQ, however it is employed in Dutch countries.[24,31] The DPAQ, used in LIME, is adapted from the IPAQ, but it refers to the last 24 hours, which may also provide information on the pattern of physical activity.[30]

Since there is no single standardized assessment method to measure these lifestyle aspects precisely, attempts to improve the quality of data is desirable. Biological samples and other complementary data have been used for such purposes. Most of the studies in this review have included at least one biological sample analysis, offering a convenient resource for validating hypotheses concerning pathophysiologic mechanisms, and/or for evaluating new biomarkers. The NutriHS has taken the opportunity to deepen the investigation of the nutritional status by including the dual-energy X-ray absorptiometry and the metagenomic analysis of gut microbiota.[22]

Most of the studies in this review have been conducted in high-income nations, except for NutriHS, carried out in a developing country with a large territory and limited resources.[22] Web-based studies are restricted to persons who have access to a computer or the ability to use the Internet. Therefore, the studies reviewed were more likely to be conducted in developed countries and the respondents were more likely to be younger and of higher educational levels than the general population, except for the studies involving health professionals. As any volunteer-based study, Web-based surveys have a limitation regarding the representativeness of participants for the general population. However, it is uncontestable that Internet penetration in many countries has increased worldwide.[11] Nowadays, over 80% of individuals in many countries have Internet access, suggesting that it might be particularly useful to enhance surveys in a near future. Indeed, in the ELF,[20] NINFEA,[27] NutriNet-Santé,[23] and PRIDE,[24] the use of the Web has allowed the gathering of data repeatedly from a large sample size.

Four[22-23,25-26] out of ten studies included in our review have been conducted with health professionals. When specialized populations with knowledge of the basics of informatics are the target sample, web surveys may be the ideal tool to minimize coverage and sampling

concerns.[14] Even though compared with the general population, health professionals are generally more health-conscious, more highly educated, and have better access to medical care; the homogeneity can be an advantage, since the similarity of the participants tends to make findings stronger within group comparisons. Additionally, this kind of sample is supposed to have skills to accurately self-report and higher compliance in long-term follow-up. In fact, scientific contributions of the HPFS and NHS in detecting lifestyle risk factors for NCCDs of Americans are remarkable.[21,25] This review identified the NMeS[26] and the NutriHS,[22] which are expected to follow the latter example, contributing to spreading high-quality evidence-based data on nutritional epidemiology.

In summary, this systematic review of Web-based surveys focused on collecting and analyzing nutritional data indicates that this strategy is appropriate for research in nutritional epidemiology as well. Since the Internet use provides detailed, quicker, and cost-effective information on lifestyle and many other factors operating across a lifespan in relation to major diseases, this kind of survey may represent a landmark in this field. With the rapid evolution and spread of these conveniences, researchers will have to adapt to this mode of communication aiming at higher compliance and more comfortable participations.

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Author contribution

LGDF and SRGF contributed significantly to the work's conception, design, data interpretation and analysis; LGDF and SRGF participated in the writing and BAP and MMP in critical revision of the article; and LGDF, BAP, MMP and SRGF read and approved the version of the manuscript being submitted.

All authors have read and have approved the final manuscript.

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Declaration of Interest

The authors declare that they have nothing to disclose.

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Figure 1 – Process for the selection of articles.

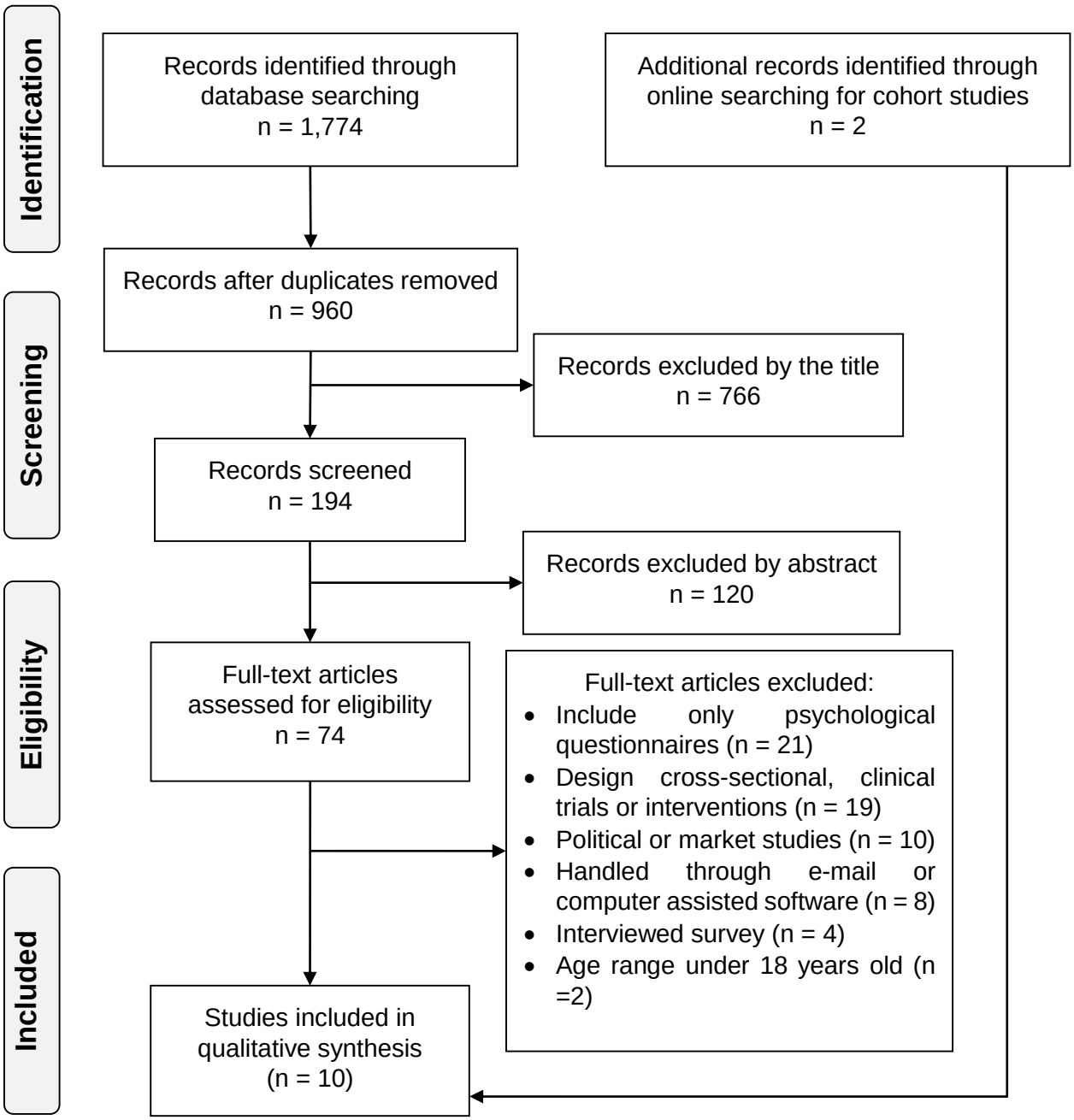

Table 1 – Main characteristics of the studies.

Study/Country	Year	Population/Sample	n	Recruitment	Main aim	Reference/Study Website
BWHS USA	1995 – ongoing	African American women aged 21–69 years	59,000	Subscribers to a magazine addressed to African Americans women, members of African Americans professional organizations, and friends of respondents	To establish prevalence and incidence rates of diseases among Black women	Russel et al. (2010)[28] www.bu.edu/bwhs
ELF New Zealand	2007 – 2013	Birth cohort: mother-child	2,197	Recruitment occurs at 'parent and child shows' marketed at expecting and experienced parents, included information in: prenatal booklets, antenatal clinics within hospitals and sonography practices, and through an internet engine search	To explore the relationship between early life exposures and the development of diseases later in life	Howe et al. (2015)[20] www.elfs.org.nz
HPFS USA	1986 – ongoing	Health professionals men aged 40-75 years	51,529	Invitations to registered health professionals men who agree to participate and if they responded to baseline questionnaire	To evaluate several hypotheses about men's health relating nutritional factors to the incidence of NCCDs	www.hsph.harvard.edu/hpfs[25]
LIME Sweden	January – May, 2004	Randomly selected Swedish population registry Men and women aged 20–60 years old	1,805	Invitations sent out via regular paper mail	To study the association of lifestyle factors with self-reported upper respiratory tract infections and with immunological markers in blood	Bälter et al. (2012)[19]
NHS III USA and Canada	2010 – ongoing	Nurses and nursing students women aged 20–60 years old	38,000 (recruiting)	Invitations to registered all nurses and nursing students who agree to participate and if they responded to baseline questionnaire	To study lifestyle, fertility, pregnancy, environmental risk factors and nursing exposures	www.nhs3.org[21]
NINFEA Italy	2005 – ongoing	Birth cohort: mother-child	7,003	Advertising through standard methods, forums on medical topics, websites dedicated to pregnant women, websites of the main Italian hospitals and associations	To investigate the effects of early life exposures on the health of newborns, infants, adolescents and adults	Richiardi et al. (2007)[27] www.progettoninfea.it
NMeS Australia, New Zealand and UK	2006 – ongoing	Nurses and midwives	8,247	E-mail to all undergraduates and registered professionals	To examine factors associated with both workforce and health outcomes	Huntington et al. (2009)[26] nurses.e-cohort.net
NutriHS Brazil	2014 – ongoing	Nutritionists and nutrition undergraduates	1,120 (recruiting)	Invitation in classrooms, attendance to university events, posters displayed in prominent locations and social network posts	To investigate the effects of early-life exposures, lifestyle habits, nutritional status and emerging risk	Folchetti et al.[22] www.fsp.usp.br/nutrihs

					factors on cardiometabolic disorders	
NutriNet-Santé Study France and Belgium	2009 – ongoing	General population older than 18 years	122,912 (recruiting)	Recruited via a vast, nation-wide, recurrent multimedia campaign	To elucidate the link between nutrition-based predictors and NCCDs incidence, healthy aging and quality of life	Hercberg et al. (2010)[23] www.etude-nutrinet-sante.fr
PRIDE Netherland	2011 – ongoing	Pregnant and child cohort: pregnant women older than 18 years	3,931 (recruiting)	Participating health care providers give verbal and written information about the PRIDE Study to pregnant women and encourage them to visit the website	To evaluate a broad range of research questions pertaining to maternal and child health and adverse developmental effects in offspring	van Gelder et al. (2013)[24] www.pridestudy.nl

Abbreviations: BWHS - Black Women's Health Study; ELF – Early Life Factors Study of Childhood Diseases; HPFS – Health Professionals Follow-Up Study; LIME – Lifestyle and Immune Function Study; NHS – Nurses' Health Study; NINFEA – Nascita e INFanzia gli Effetti dell'Ambiente; NMeS – Nurses and Midwives e-cohort Study; NutriHS – Nutritionists' Health Study; PRIDE - PRegnancy and Infant Development; USA – United States of America; UK – United Kingdom.

Table 2 – Content of the questionnaires included in the studies.

Study	Sociodemographic data	Diet and tool	Physical activity	Clinical and medication history	Anthropometric measures	Biological samples	Others
BWHS	✓	✓ FFQ	✓ BWHS' instrument	✓	✓ Self-reported	✓ Medical records gather	• Menstrual/reproductive history • General questions on violence, night work, religion • Psychological aspects
ELF	✓	✓ FFQ	✓ Few questions on physical activity	✓	✓ Self-reported	Not collected	• Reproductive factors • Cognitive development • Sleep patterns • Maternal and infant behaviors and habits
HPFS	✓	✓ FFQ and complementary dietary data	✓ HPFS' instrument	✓	✓ Self-reported	✓ Blood and urine samples	• Dental • Psychosocial aspects
LIME	✓	✓ FFQ	✓ DPAQ	✓	✓ Self-reported	Not collected	• Stress • Sleep habits • Upper respiratory tract infections
NHS III	✓	✓ FFQ and complementary dietary data	✓ NHS' instrument	✓	✓ Self-reported	✓ Blood and urine samples	• Dental • Sleep habits • Psychosocial aspects
NINFEA	✓	✓ FFQ	✓ Few questions on physical activity	✓	✓ Self-reported	✓ Maternal and infant saliva sample	• Reproductive factors • Cognitive development • Sleep patterns • Maternal and infant behaviors and habits
NMeS	✓	✓ FFQ	✓ IPAQ	✓	✓ Self-reported	Not informed	• Psychological aspects • Work-related concerns • Job stress • Muscle-skeletal health

NutriHS	✓	✓ FFQ and complementary data on supplements	✓ IPAQ	✓	✓ Self-reported and measured	✓ Blood and feces	• Early-life events • Gut microbiota • Body composition
NutriNet-Santé Study	✓	✓ 3 24HR, FFQ and complementary dietary data	✓ IPAQ	✓	✓ Self-reported Sub-sample: measured	✓ Blood and urine sample	• Psychological aspects
PRIDE	✓	✓ FFQ and complementary data on suplements	✓ SQUASH questionnaire	✓	✓ Self-reported	✓ Maternal blood and saliva sample and medical records gather	• Maternal and child Health; • Occupation and living conditions; • Health care and well-being; • Delivery and infant Health; • Psychological aspects; • Pharmacy record

Abbreviations: : BWHS - Black Women's Health Study; ELF – Early Life Factors Study; HPFS – Health Professionals Follow-Up Study; LIME – Lifestyle and Immune Function Study; NHS – Nurses' Health Study; NINFEA – Nascita e INFanzia gli Effetti dell'Ambiente; NMeS – Nurses and Midwives e-cohort Study; NutriHS – Nutritionists' Health Study; PRIDE - PRegnancy and Infant Development; 24HR – 24-hour dietary records; DPAQ – Danish Physical Activity Questionnaire; FFQ – Food Frequency Questionnaire; IPAQ – International Physical Activity Questionnaire; SQUASH – Short QUestionnaire to Assess Health-enhancing physical activity.

Table 3 – Strengths and limitations of the web-based surveys reviewed.

Study	Limitations	Strengths
BWHS	• Participants used to paper-and-pencil questionnaires • Restricted to persons who have access to a computer or online network • Self-reported anthropometric measures	• Option of offline paper-based questionnaires • Large sample size • Representativeness of African-American population • Long follow-up and repeated data collection • High internet pervasiveness (87.4%)[11]
ELF	• High loss to follow-up (52.5%) • Majority took part via paper-based postal copy (55.0%) • Restricted to persons who have access to a computer or online network • Self-reported anthropometric measures • Website not available	• Option of offline paper-based questionnaires • High internet pervasiveness (93.8%)[11]
HPFS	• Participants used to paper-and-pencil questionnaires • Non-representative sample of the general population • Self-reported anthropometric measures • High similarity among participants • Selection bias (motivated participants, high educational level) • Easy access to medical care	• Option of offline paper-based questionnaires • Large sample size • Long follow-up and repeated data collection • Accuracy of self-reported data collected • High compliance in long-term study • Easy sample identification and tracking • Internet access
LIME	• Restricted study aim • Short follow-up • Restricted to persons who have access to computer or online network • Self-reported anthropometric measures • Website not available	• High internet pervasiveness (94.6%)[11]
NHS III	• Non-representative sample of general population • Self-reported anthropometric measures • High similarity among participants • Selection bias (motivated participants, high educational level) • Easy access to medical care	• Large sample size • Accuracy of self-reported data • High compliance in long-term study • Easy sample identification and tracking • Internet access
NINFEA	• Language-related limitation (only in Italian) • Selection bias (educational level, smoking habits, parity history) • Restricted to persons who have access to computer or online network • Self-reported anthropometric measures	• Life-course study • Large sample size
NMeS	• Non-representative sample of the general population • Self-reported anthropometric measures • High similarity among participants • Selection bias (motivated participants, high educational level) • Easy access to medical care	• Large sample size • Second wave and repeated data collection • Accuracy of self-reported data • High compliance in long-term study • Easy sample identification and tracking • Internet access
NutriHS	• Language-related limitation (only in Portuguese) • Non-representative sample of general population • High similarity among participants	• Low cost for development • Potential for amplification • Self-reported and measured anthropometric data • Accuracy of self-reported data

	• Selection bias (motivated participants, high educational level)	• High compliance in long-term study • Easy sample identification and tracking • Internet access
NutriNet-Santé Study	• Language-related limitation (only in French) • Restricted to persons who have access to computer or online network	• Large sample size • Potential for amplification • Potential for amplification • High internet pervasiveness (83.8% France and 85.0% Belgium)[11]
PRIDE	• Language-related limitation (only in Dutch) • Selection bias (high educational level) • Self-reported anthropometric measures	• Large sample size • Life-course study • Potential for amplification • Linkage with medical records and existing registries • Option of offline paper-based questionnaires • Long follow-up and repeated data collection • High internet pervasiveness (95.5%)[11]

Abbreviations: BWHS - Black Women's Health Study; ELF – Early Life Factors Study; HPFS – Health Professionals Follow-Up Study; LIME – Lifestyle and Immune Function Study; NHS – Nurses' Health Study; NINFEA – Nascita e INFanzia gli Effetti dell'Ambiente; NMeS – Nurses and Midwives e-cohort Study; NutriHS – Nutritionists' Health Study; PRIDE - PRegnancy and Infant Development.

ARTIGO 2

Development of web-based system for a cohort study: the Brazilian e-NutriHS

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Keywords: Electronic health records, Health information on the web, Web-based system, Cohort study, Nutrition.

Abstract: This study describes a web-based system developed to gather online information on health of college students and graduates in nutrition, the e-NutriHS. The Nutrititionist Health Study – NutriHS is planned to be a cohort study aiming to collect health-related data at a 3-year interval. The e-NutriHS consists of 6 questionnaires regarding demographic and socioeconomic data, dietary habits, physical activity, alcohol and tobacco uses, anti-fat attitudes and personal and family histories. Validated and internationally recognized lifestyle instruments were used. Our software and respective database are hosted in the School of Public Health server; the software is based on free programming languages. e-NutriHS data obtained from questionnaires can be transferred to excel format. An e-NutriHS prototype was created preceding online attachment. An improved version of website was released based on 20 volunteers' opinions. 503 users were already registered. Our initiative of building a website designed for collecting data for epidemiological studies, tailored to our local reality, is innovative under the perspective of the health informatics available in the developing world. Considering that web-based systems produce reliable data, are easy to use, less costly and less time-consuming, we conclude that our experience deserves to be shared, particularly with middle-income economy countries.

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1 INTRODUCTION

In recent years, the use of the Internet by the populations, in particular for healthcare information provision, is markedly increasing. This represents a desirable scenario, but it is worrying that sometimes there is a lack of scientific evidence which could have harmful impact in individuals. In light of this growth, researchers of health sciences have invested in learning how to use the Web to spread high-quality evidence-based data. Such initiatives have developed their abilities to deal with electronic tools for data collection and report, recognizing benefits as well as pitfalls on using the Web. Since nutrition is a key element for health, this issue represents one of the most explored.

Research studies in epidemiology are often conducted in hundreds or thousands participants, followed for long periods of time. These studies generate a significant amount of data, requiring trained professionals with specialized skills for data collection and processing. Health surveys have been mostly based on paper questionnaires. Their quality depends on accuracy in collecting, sorting, coding, typing and checking of data to create a consistent database before analysis. These steps are expensive and time-consuming, prolong the study duration, but are essential for the adequate data analysis and results interpretation to achieve reliable conclusions. Until recent years, relevant epidemiological studies were based on paper-and-pencil surveys, particularly those concerning lifestyle data (Colditz and Hankinson 2005, Wilson et al. 2012, Hu et al. 1997).

Technological advances have allowed obtaining standardized and reliable data in a faster and less expensive way. The completion of data electronically can ensure almost immediate construction of database, reduce costs, errors and biases and minimize duplicate information. This has largely motivated the use of the Web, for instance in nutritional epidemiology. Researchers in nutrition commonly deal with analysis of dietary intake, usually collected by questionnaires and/or food recalls. Several softwares are available for data analysis, tailored to dietary habits of a given population. In contrast, a direct link between questionnaires completion and data processing for analysis is missing. Few softwares, specifically designed to play this role, are found in literature and none in developing countries. Web-based questionnaires applied in the nutrition field would facilitate the “dialogue” of data collected with software to dietary reports, as well as to statistical procedures.

The development of web-based online self-administered systems, employing validated health-related surveys, sociodemographic status, dietary habits and personal and family medical history, with a link for online scheduling for face-to-face data collection is warranted. Such system to obtain health-related data would be particularly important in middle-income economy countries where resources for researches are limited. It is anticipated that these methods will become a more feasible way of implementing surveys, providing a number of advantages over traditional methods, including convenience for the participant, potentially large cost savings for the researcher, efficiency in data collection, higher data quality, a degree of perceived anonymity for the participant, and high response rates (Best et al. 2001, Hewson et al. 1996, Krantz et al. 1997, Schaefer and Dillman 1998, Schmidt 1997, Shettle and Mooney 1999).

In Brazil, initiatives for electronic collection of data for monitoring health aspects are rare. A national health survey, the Telephone-based Surveillance of Risk and Protective Factors for Chronic Diseases, under the coordination of the Ministry of Health and supported by the University of Sao Paulo and the Center for Disease Control, uses desktop software to obtain data of the Brazilian population but requires trained interviewers (Azevedo e Silva et al. 2011). To our best knowledge, self-administered online questionnaires have not been reported.

The purpose of the current study was to describe

a web-based system developed to gather information on health of a specific subset of the Brazilian population, allowing participants to complete data online. Characteristics of the participants were established based on their potential skill to navigate on the Internet and on the expected high quality of data provided. The choice of nutrition college students and graduates fulfills these criteria.

2 LITERATURE REVIEW

2.1 Epidemiological studies of health professionals

Monitoring of nutritional and lifestyle factors associated with changes in health conditions in epidemiological studies has contributed to identify modifiable risk factors, to deepen the understanding of the pathophysiology of diseases, especially non-communicable chronic diseases (NCD) and to propose interventions. In this sense, experiences involving health professionals have brought significant contributions to the knowledge about the role of behavioral factors on health outcomes of Americans (Colditz and Hankinson 2005, Wilson et al. 2012, Hu et al. 1997). Particularly, cohort studies due to their longitudinal design have provided the most relevant evidence.

Approaches to gather information in cohort studies have been mainly based on face-to-face and/or telephone interviews, using paper-and-pencil questionnaires. The Nurses' Health Study I and II and the Health Professionals' Follow-up Study including thousands of participants in North America, are remarkable considering their scientific contributions for identifying lifestyle risk factors for NCD (Colditz and Hankinson 2005, Wilson et al. 2012, Hu et al. 1997). Despite the use of paper-and-pencil questionnaires, those studies had the strength of involving professionals that guarantee a high quality of data collected. Other epidemiological studies with similar objectives were conducted in America and Europe, including smaller samples and non-restricted to health professionals (Turner et al. 2009, Mikkelsen et al. 2009).

In this century, researches using web-based questionnaires have gained significant popularity (Couper 2000). More frequently, they have been used in psychological studies and marketing research, but in the field of epidemiology, Internet tools were employed in less than 1% of the reported studies (van Gelder et al 2010). The Millennium Cohort Study (Smith et al. 2007), the Nurses and Midwives e-Cohort Study (Turner et al. 2009), and the Danish Web-based Pregnancy Planning Study (Mikkelsen et al. 2009) are examples of successful large cohort studies where de recruitment and follow-up occur over the Internet.

In developing countries, similar initiatives involving health professionals are rare and, considering the use of Internet as a tool for data collection, are inexistent. In countries with a large territory and limited resources like Brazil, the development of a cohort study able to identify environmental risk factors, based on web-based tools would be highly desirable. Therefore, in 2014, our research group, working for a recognized Brazilian reference academic institution, decided to develop a study with those characteristics, the Nutritionist Health Study – NutriHS (www.fsp.usp.br/nutrihs).

2.2 Web-based data collection

Epidemiologists conducting cohort studies often work with huge amount of data to evaluate the relationship between exposures and outcomes at multiple points in time. Application of these methods based on paper-and-pencil questionnaires requires trained professionals for collecting, sorting, coding, typing and checking data. These studies frequently are relevant for actions in public health demanding agility to be implemented. Therefore, researchers have been abandoned traditional methods, replacing by Web-based data collection.

Web-based questionnaires have several advantages compared with traditional tools, including data quality, reduction of costs and time from the study initiation to the receipt of

analysable data (Schleyer and Forrest 2000, Wyatt 2000). The interactive element of this system allows the inclusion of visual aids; design issues can be simplify for responders; and also the scripts of the website can be immediately adjust to solve unforeseen problems or to incorporate preliminary results (van Gelder et al. 2010). Costs for printing, postage, and data coding and entry are avoided. On the other hand, the set-up costs, including programming and design, may be too high in studies with small sample sizes or in populations with low response rates (Adams and White 2008, Rodriguez et al. 2006, Dillman 2007).

During survey implementation on the Web, there are unknown issues prompting some authors to express concerns (Best et al. 2001, Schaefer and Dillman 1998, Smith 1997). These concerns include sampling problems, lack of participant access to computers with Internet connections, security, and response inconsistency across different media. The possibility of bias associated with collecting information over the Web previously raised is no greater than that introduced by traditional paper methods (Ekman et al. 2006).

In summary, it is notable that the majority of respondents prefers Web-based version to postal questionnaires or telephone interviews (Rankin et al. 2008, Touvier et al. 2010). This is particularly true for young people who were born during the Internet era. Being a more attractive method of data collection, more Web-based systems tended to be developed for epidemiologic studies.

3 MATERIAL & METHODS

This chapter includes details on the users of the e-NutriHS, as well as the instrument (e-NutriHS) and its prototype for pre-testing. The NutriHS was conceived during the year 2013 by our research group from the School of Public Health of the University of São Paulo, Brazil. The NutriHS is planned to be a cohort study mainly involving students of Nutrition Graduation Courses from Universities located in the State of Sao Paulo, but also graduates. For its first phase, launched in 2014, they are being invited to participate in the study, in which health-related data will be collected at a 3-year interval.

A web-based system was developed to gather information online of this specific subset of the Brazilian population, the e-NutriHS. Our software is unique, tailored to the researchers' purposes and to local requirements of the university server.

3.1 e-NutriHS users

The choice of nutrition college students and graduates was based on four presumed conditions: a) potential skill to navigate on the Internet; b) availability of computer and Internet connections; c) expected high quality of data provided; d) local facilities in our University.

Nutrition students and graduates are being invited to this first phase of NutriHS. The ethical committee at FSP-USP approved this study. All student or graduate who accepts participation has signed Statement of Informed Consent electronically prior the fulfilment of questionnaires.

The ones who agree to participate are being investigated about the role of lifestyle habits on health conditions. Instruments used to collect feedback from users were e-mail and Facebook.

3.2 Survey instruments

The e-NutriHS includes of 6 questionnaires regarding demographic and socioeconomic data, dietary habits, physical activity level, alcohol and tobacco use, anti-fat attitudes and personal and family medical histories. Contact information was obtained to help the participant tracking during the follow-up. Validated and internationally recognized lifestyle tools were used, since standardization is necessary for comparisons with other populations. Main tools employed in the NutriHS include the International Physical Activity Questionnaire (IPAQ) (Craig at al. 2003), Food Frequency Questionnaire (FFQ) (Fisberg et al. 2008) and the Antifat Attitudes Questionnaire (Lewis et al. 1997).

3.3 Online social network and website

Colors for the website were carefully selected; green and orange are related to health, nutrition and youth. During the software building process, ease of use was frequently reviewed until become a friendly version. All the questionnaires were inserted in the website exactly as the printed version, except for essential instructions for completion. The length of each questionnaire page was defined based on a comfortable time for filling. Our logotype was created reinforcing the impact of increasing knowledge about nutrition on health.

In order to increase awareness of the NutriHS a social page in the Internet was created before starting the data collection. The most popular social network – the Facebook – was chosen to publicize the study (Figure 1).

Figure 1: Social online network of NutriHS (https://www.facebook.com/nutrihs)

Our page in Facebook includes a link to the e-NutriHS homepage. This place has also represented an important vehicle to disseminate scientific knowledge on nutrition for Internet users and to support the dialogue among researchers and users.

With the University of São Paulo Informatics Center support, the e-NutriHS website (Figure 2) was developed to expedite and further analyse data generated from the first phase of the NutriHS.

As our software and respective database would be hosted in the School of Public Health server, our team had to build the web system which was based on free programming languages, such as HyperText Markup Language (HTML), Cascading Style Sheets (CSS), JavaScript, Hypertext P reprocessor (PHP) and Structured Query Language (SQL), in database management system MySQL.

Figure 2: The e-NutriHS website (http://www.fsp.usp.br/nutrihs/index.html)

Before fulfilling the questionnaires, users are required to create a unique login and password. Afterwards, their access to questionnaires is released. When users enter incomplete or implausible answers, prompts alert them to complete or to check information. Each page must be saved at the end in order to feed database. User workflow is depicted in Figure 3. e-NutriHS data obtained from any questionnaire can be transferred to excel format and provide print reports. Dietary data are immediately processed permitting estimates of daily energy and nutrient intakes, based on the nutritional composition data of the USDA National Nutrient Database for Standard Reference.

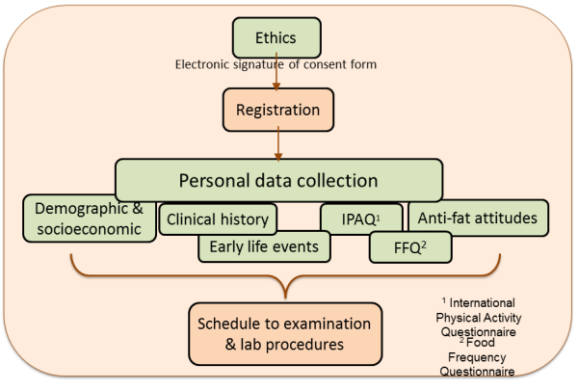

Figure 3: User online workflow

3.4 The e-NutriHS prototype

A prototype of e-NutriHS was created preceding online attachment for NutriHS users and hosted on a temporary url in order

to test the system and to check its ease-of-use, data entry and website design.

Twenty volunteers, graduates at the School of Public Health who have been worked in the health area, aged 25 to 60 years old, were invited to test the prototype. They did the online registration and answered to all questionnaires.

To check if answers were accurate, one questionnaire per person was randomly chosen for paper responses, sent by e-mail. The volunteers also answered four simple questions about the design, method preferred and ease-of-use of the website:

1. Which method do you prefer?
2. Is attractive the design of the website? Would you change anything?
3. Were the questionnaires easy to answer?
4. Did you have any kind of problem when navigating the site?

4 INITIAL FINDINGS

4.1 Prototype results

In average, volunteers fulfilled the web-based questionnaires 30 minutes after they had received the temporary url, meaning that these data were already ready to be analyzed. Regarding the paper version, they returned it at least one day after e-mail delivery. It is important to take into consideration that those paper questionnaires still needed to be coded to enter the database.

Based on the comparative analyses of the prototype with paper questionnaires, some technical problems were detected in the FFQ. These script errors were properly adjusted and solved.

Users preferred web-based method over the traditional one, considered the website attractive, made favourable comments about the colours used and the interactive elements and suggested no change. The questions were considered simple and the prompts convenient, facilitating fulfilment. No problem was mentioned related to navigation. An improved version of website was released based on the volunteers' opinions.

4.2 NutriHS preliminary results

In March 2014, NutriHS participants have started to use the online web-based system. No complain on e-NutriHS access and use has been reported. In general, users' satisfaction seems to be positive since only favourable comments have been received.

A total of 503 users were registered, being 459 college students and 44 graduates. Predominance of female sex was detected (93%) which was expected since the majority of nutrition students are women. Mean age of the sample is 23.8 (SD 6.6) years; 63.5% are Caucasian and 84.6% single.

Preliminary data on energy and nutrient intakes, physical activity levels, alcoholic beverages and tobacco uses and others are available allowing comparisons of students' profile at the beginning and end of the course. These conditions are in contrast with the nutritional epidemiological studies, which require a long period to get results.

Summaries of scientific papers on nutrition recently published should be responsible – at least in part – to the high access to our social network.

Taken together, these preliminary results should bring relevant information not only for the student, graduate and researcher but also to the academic institutions' staff.

5 LIMITATIONS & STRENGHT

There is a lack of originality in using web-based system to collect and disseminate health information. However, its use in cohort studies, conducted in emerging countries, exploring the lifestyle impact on health conditions, is rare. As far as we know, in Brazil, this kind of web-based research in nutritional epidemiology is a novelty.

The applicability of the current instrument is limited since this was specifically created for a subset of professionals. However, similar web-based systems could be adapted for other practices. Particularities of our design site limit comparisons with other similar web systems available.

6 CONCLUSIONS

Our initiative of building a website designed for collecting data for epidemiological studies, tailored to our local reality, is innovative under the perspective of the health informatics available in developing world.

Preliminary findings suggested that e-NutriHS may be useful to obtain data with potential to identify gaps and/or problems in graduation process as well as health disorders. In parallel, we speculate that this website might encourage students to search for e-learning on nutrition. Also, it is expected that college authorities could obtain some subsidies to review aspects of the academic curriculum.

Considering that web-based systems produce reliable data, are easy to use, less costly and less time-consuming, we conclude that our experience deserves to be shared, particularly with middle-income economy countries.

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ARTIGO 3

The Nutritionists' Health Study cohort: a web-based approach of life events, habits, and health outcomes

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KEYWORDS

Nutritionists' Health Study, Web-based System, Early-life events, Gut microbiota, Cardiometabolic risk factors

Word Count: 3,568

ABSTRACT

INTRODUCTION Non-communicable chronic diseases (NCCDs) represent a burden for public health. Alongside, the established cardiometabolic risk factors – high blood pressure and disorders of glucose and lipid metabolism – living habits and nutritional status at different stages of life are seen as contributors for this scenario. Gut microbiota composition and subclinical inflammation have been pointed out as underlying mechanisms of NCCDs. Studies involving health professionals have brought relevant contributions to the knowledge about risk factors. Technological advances facilitate data collection and analysis for big samples. Web-based survey addressed to collect data from a cohort study, able to identify NCCDs risk factors, is highly desirable. The objective of the Brazilian Nutritionists' Health Study – NutriHS is to gather online information on early-life events, daily habits, emergent cardiometabolic risk factors and health outcomes of a specific subset of the Brazilian population. **METHODS AND ANALYSIS** The NutriHS, developed at the School of Public Health – University of Sao Paulo, Brazil, is a research initiative that enrolls undergraduates of nutrition courses from Brazilian universities and graduated volunteers. A web-based self-administered system was designed to collect health-related data. After fulfilling online questionnaires (socioeconomic, early-life events and lifestyle data), participants are invited to a clinical visit for physical examination and lab procedures (blood sampling, feces collection and body composition). At a 3-year interval, they will be invited to repeat similar procedures. **ETHICS AND DISSEMINATION** The NutriHS research protocol was approved by the Institutional Ethics Committee and is providing promising data which contribute to the understanding of pathophysiological links between early life events, body composition, gut microbiota and inflammatory and metabolic risk profile. The combination of a friendly tool with the innovative purposes of NutriHS offers a remarkable resource for testing hypotheses about mechanisms of nutrition-related diseases and further planning of preventive programs in public health.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- A web-based prospective study for collection of self-reported multidisciplinary data
- Low cost for development and potential of amplification of the web-based system
- Availability of self-reported and measured data which allows validation study
- Innovative data to be associated with early outcomes
- Characteristics of the population sample which has skills to accurate answers to self-reported technical questionnaires and potential high compliance in the long-term study
- Language-related limitation offered in the web-based system (only in Portuguese)
- Non-representative sample of general population

INTRODUCTION

Numerous factors from intrauterine life and birth determine adult health and well-being. Monitoring of early-life events and daily habits has provided tools to protect individual health from major damage and other threats. Health outcomes depend on a combination of genetic and environmental factors.

Delivery conditions, birth weight, and early events in infancy have been involved in the genesis of future diseases [1-4]. Such a relationship, initially raised by Barker [5], has been further confirmed [6-9], although underlying mechanisms are not yet completely understood. More recently, the types of delivery and child nutrition have been shown to influence the gut microbiota composition which, in turn, modulates immune system and the risk of diseases [10-13].

Epidemiological and clinical studies have contributed towards identifying modifiable risk factors and deepening the understanding of the pathophysiology of non-communicable chronic diseases (NCCDs), such as obesity, type 2 diabetes mellitus, and cardiovascular disease. These lifestyle-related morbidities represent a heavy burden for public health systems due to complications, increased mortality, and high costs [14-16].

Knowledge of risk factors for NCCDs, collected prospectively, is essential for enhancing evidence and planning interventions. Epidemiological studies involving health professionals have brought significant contributions to the knowledge about the role of

behavioral factors in health outcomes [17,18]. This kind of study often requires large population samples, followed for long periods, which generate a significant amount of data, high costs, and the need for trained professionals [15-18]. More commonly, health surveys have been based on paper-and-pencil questionnaires.

Printed questionnaires-based surveys are complex and time-consuming, and their quality depends on accuracy in data collecting, processing and uploading to create a consistent database before analysis. Despite extending study duration and representing a financial burden, these steps are crucial for adequate data analysis to achieve reliable conclusions [19,20].

Technological advances can minimize errors and duplicated information, reduce costs, as well as provide the almost immediate construction of a database using bioinformatic tools [20,21]. Multiple and diverse software for data analysis tailored to specific questions are available, but very few are designed specifically to investigate the role of early-life events and daily habits.

The Internet is a promising tool for overcoming some of the logistic and financial feasibility constraints in research, and is gaining considerable popularity [21]. In contrast to other fields – such as in psychological and marketing research – in epidemiology, less than 1% of the reported studies are internet-assisted [14]. Successful examples of large-scale studies in which enrolment and follow-up occur over the Internet are the Millennium Cohort Study [22], the Nurses and Midwives e-Cohort Study [23], and the Danish Web-based Pregnancy Planning Study [24]. In nutritional epidemiology, there is the NutriNet-Santé Study, a web-based prospective study launched in France in 2009 [25].

In middle-income countries, similar initiatives using the Internet as a tool for data collection are scarce, and when considering the inclusion of health professionals they are inexistent. The development of web-based surveys able to identify environmental risk factors in developing countries with wide geographic area and limited resources would be highly desirable. As far as we know, the use of self-administered online questionnaires for this kind of population has not yet been reported.

The purpose of the current study was to describe the methodology of the Nutritionists' Health Study (NutriHS), a prospective Web-based study developed at the School of Public Health, University of São Paulo (FSP/USP), Brazil, to gather information on early-life events, daily habits, emergent cardiometabolic risk factors, and health outcomes of a specific

subset of the Brazilian population – undergraduates and graduates in Nutrition. The outcome of major interest is excessive body weight and obesity-related morbidities.

METHODS AND ANALYSIS

Implementation of the NutriHS study included the following steps: 1) development of the web-based system; 2) collection of data related to early-life events, lifestyle habits, anthropometry, and body composition; 3) assessment of the cardiovascular profile based on traditional and emerging risk factors; 4) analysis of the association of early-life events and lifestyle habits with the gut microbiota composition, and cardiovascular risk factors.

- **The Web-based system**

With the support of the FSP/USP Informatics Center, a dedicated Web-based online self-administered system (http://www.fsp.usp.br/nutrihs/index.html) was developed, named *e*-NutriHS, to collect health-related data based on previously validated printed questionnaires. Details on its development have been described elsewhere [26]. In brief, the Web-based system was built using free programming languages: HyperText Markup Language (HTML), Cascading Style Sheets (CSS), and JavaScript used to create a working dynamic website with friendly user's interface; the Hypertext P reprocessor (PHP), server-side scripting language, used to transfer of data to the NutriHS database; and Structured Query Language (SQL) is the database programming language used at the database management system, MySQL.

The colors for NutriHS website – green and orange – refers to health, nutrition and youth. The logotype and slogan call attention to the need of increase knowledge on the role of nutrition for health.

The development also included skip patterns to hide questions (depending on the person's answer to a prior question), randomly organized questions, and validation checks providing additional information to simplify and help responding, pointing out questions that needed attention. The *e*-NutriHS data can be transferred to Excel format, allowing further analyses. Since the database is located at the FSP/USP server, its security was guaranteed.

Prior to releasing the *e*-NutriHS to participants, a prototype was created [26]. Twenty volunteers, graduates at the FSP/USP who have been working in the health area, aged 25 to

60 years, tested the system and checked its ease-of-use, data entry, and website design. Based on their opinions, a user-friendly version of *e*-NutriHS was released.

The website provides details on the study purposes, the team involved, and contact information, and also represents an opportunity for learning with recent research reports from international literature. In order to increase awareness of the NutriHS, a social network page on the Internet was created (https://www.facebook.com/nutrihs) with a direct link to the *e*-NutriHS homepage. This website plays an important role in stimulating dialogue among researchers and participants.

- **Study design, recruitment, and inclusion**

Given the growing recognition of the importance of the life course approach for understanding the determinants of NCCDs, the NutriHS was designed to be a cohort study in which retrospective and prospective data are being collected. The study was designed to include all undergraduates and graduates from Brazilian Nutrition Colleges, aged ≥18 years. Undergraduates from Nutrition courses and nutritionist volunteers were selected based on their potential skill to navigate the Internet and on the expected high quality of data provided. Exclusion criteria are pregnancy and no access to the Internet.

Volunteer recruitment was done using multiple strategies. Invitations were made to the university staffs, lectures for undergraduates or graduates were offered, news was published on the FSP/USP website and on the NutriHS social network page, and banners were placed in strategic places.

After signing the electronic informed consent, users are required to fill out personal data and to create a unique login and password. Then, their access to questionnaires is released. Once questionnaires completed, participants are instructed to schedule, on the *e*-NutriHS, a face-to-face visit at the Health Center for clinical examination and biological sampling. Recruitment started in March 2014 and this is planned to be completed by July 2016. After a 3-year interval, they will be invited to complete a similar set of questionnaires.

- **Questionnaires and variables of interests**

The baseline set of questionnaires deals with socioeconomic, early-life events, and lifestyle data, including physical activity and eating habits. The order for filling out these questionnaires is chosen by the participant. Excessive body weight is a major outcome, which is being assessed using anthropometric measurements and densitometry. Other variables will be used as exposures, predictors, potential confounders, or effect modifiers.

1. Demographic, socioeconomic lifestyle, and clinical questionnaires

The structured questionnaires obtained data regarding skin color, educational level, marital status, person(s) they live with, parents or guardians, family income, number of people in the house, work, work hours, use of medications, medical history, familial medical history, a restrictive diet, alcohol consumption, tobacco consumption, height, and weight.

2. Early-life events questionnaire

The contents of this questionnaire allow one to obtain retrospective information about the mothers of the participants, their pregnancies, and data related to birth and childhood, as well as maternal health and educational level during the pregnancy period. Before filling the questionnaire, instructions are provided, recommending participants to ask their parents (mainly mothers) or to look at their birth registry to get specific information regarding gestational period and early-life events.

Data collected are divided into two parts regarding mothers and participants. Mother's age at the participant's birth, educational level, occupation, height, weight before pregnancy, use of medications, pregnancy conditions, such as weight gain and health problems, are reported. Also, participants are asked to answer as to prematurity, twins, birth weight, breastfeeding, time of breastfeeding, time of introduction of formula, medications used, weight gain during childhood and adolescence, fruit and vegetable consumption, and physical activity during childhood.

3. Physical activity questionnaire

The short version of the International Physical Activity Questionnaire (IPAQ), validated for the Brazilian population [27], is being employed. Intensity of physical activity (walking, moderate and intense), frequency (per week), and duration are obtained. These data enable estimates of total physical activity as quantitative or categorical variables (low, moderate, and high). A sedentary pattern has been assessed by time spent sitting.

4. Dietary assessment

Diet is assessed using a validated 102-item food frequency questionnaire [28] regarding eating habits over the last year. Data inserted into the *e*-NutriHS are immediately transformed into the equivalent food amounts for one day. The system is able to provide reports of macro- and micronutrients, based on the USDA National Nutrient Database for Standard Reference.

5. Clinical assessment

Completion of questionnaires is required in order to access the link for scheduling the face-to-face visit to the FSP/USP Public Health Center. A couple of days before the visit, an e-mail with instructions for biological sampling and body composition determination is sent to each participant. This visit represents an opportunity to double-check previously collected selected data.

- ***Anthropometry and blood pressure***

Weight is obtained on a digital scale accurate to 100 g and height was measured using a fixed stadiometer to the nearest 0.5 cm. They are used to determine the body mass index, which was calculated as weight in kilograms divided the square of the height in meters (kg/m^2). Waist circumference is taken in centimeters at the midpoint between the lowest rib and the iliac crest. Body composition is being determined by dual-emission x-ray absorptiometry (DXA Lunar GE) that allows accurate estimates of body compartments, including visceral fat. Sitting blood pressure levels are measured using an automatic device, expressed in mm Hg.

- ***Biochemical data***

Blood samples are collected for plasma glucose and lipid profile, determined using the hexokinase method and enzymatic colorimetric assay, respectively. Aliquots are frozen at -80°C for further determinations of apolipoproteins, hormones, and inflammatory markers. Insulin is determined by enzyme-linked immunoenzymatic assay (ELISA) and high-sensitivity C-reactive protein by immunochemistry. ELISA kits are also used for the measurements of cytokine concentrations. Insulin resistance will be estimated by the HOMA-IR index [29]. Extra aliquots are stored for future analyses of interest to the NutriHS.

- ***Metagenomic analysis of gut microbiota***

Participants are instructed to collect a fecal sample and refrigerate it before the visit. Aliquots are frozen until the metagenomic analysis. The pyrosequencing of 16S subunit ribosomal amplicons will be performed using next-generation sequencing technology. After obtaining the sequences, they are subjected to phylogenetic analysis to characterize the fecal microbiota. Bioinformatic procedures, comparing the sequences extracted from the fecal samples with standardized databases, allow determination of the abundance of bacteria belonging to phyla and genera.

- **Data and statistical analysis plan**

The NutriHS planned to collect prospectively data on emergent lifestyle-related risk factors of a specific subset of the healthy Brazilian population. For its cross-sectional phase, data analyses included the description of the population sample to be followed. Additionally, a validation sub-study of the web-collected self-reported data is being conducted. A number of statistical analyses has been planned to test associations of knowledge in nutrition and changes in lifestyle, as well as in body composition and biochemical profile.

Analyses are being performed using IBM SPSS Statistics V. 20.0. Collected measures and derived variables will be summarized using means and standard deviation (SD), medians and interquartile range (IQR), and/or frequencies. Student *t* test or one-way analysis of variance when comparing more than two groups will be used for continuous variables with normal distribution. Pearson correlation coefficient will be employed to test correlations. Correspondent non-parametric tests will use for non-normal distributed variables. For validation studies, agreement has been analyzed by Kappa statistics and Bland-Altman plot method. For multivariate analyses, generalized linear regression models will be used or logistic regression for dichotomous variables. For all tests, a p-value < 0.05 will be considered significant.

ETHICS AND DISSEMINATION

Ethics

The NutriHS study protocol and study documentation, including all questionnaires and the informed consent, was approved by the Institutional Ethics Committee, Committee for Ethics in Research, School of Public Health, University of Sao Paulo. The substantiated opinions were registered by the numbers: Of. COEP 991.542/15 and Of. COEP 257.513/13.

When accessing the *e*-NutriHS, participants must sign an electronic informed consent before the registration process. Individual privacy is respected and data will be stored in *e*-NutriHS database following the regulations applied to security. All publications will respect confidentiality.

Discussion and Dissemination

Analyses involving the issue cardiovascular risk factors & public health, anchored in population-based studies or specific population subsets have been conducted in developed

countries. Such studies are of great relevance for proposals and formulation of public policies tailored to local situations. Cohorts of health professionals, like the Nurses' Health Study I and II (http://www.channing.harvard.edu/nhs/) and the Health Professionals Follow-up Study (https://www.hsph.harvard.edu/hpfs/), which included thousands of participants in North America, brought remarkable scientific contributions for identifying and intervening in major risk factors for NCCDs [17-18]. One strong point of studies involving professionals is the high quality of the specific data collected.

The current Brazilian epidemiological scenario of increasing longevity and nutritional transition highlights the importance of obesity-related chronic diseases for mortality. Along with the traditional cardiometabolic risk factors – hypertension and impaired metabolism of glucose and lipids – lifestyle and nutritional status in different stages of life, including the intrauterine period, have been pointed out as relevant determinants of this situation [3,8,30]. Scientific evidence has associated low birthweight, cesarean delivery, and formula milk feeding with excessive body adiposity and type 2 diabetes mellitus in adult life [31-37]. Recently, Brazil exhibited relatively high rates of undernutrition; therefore, mothers of the NutriHS participants might have come from adverse conditions. Since it has been reported that the second generation is the one that suffers the biggest health impact (38,39), our study represents an opportunity for investigating risk factors for chronic diseases or even their early outcomes.

The atherosclerotic process and insulin resistance markers, both directly associated with the immune system, and subclinical inflammation, have been considered emergent risk factors [40-42]. The NutriHS is providing promising data which may contribute towards deepening the understanding of pathophysiological links of early life events, body composition, and inflammatory risk profile. The gut microbiome is meant to have a central role in mediating immune system alterations that predispose to a proinflammatory status and metabolic disorders [43-45]. Studies about gut microbiota have fomented the hypothesis of dysbiosis early in the cycle of life, triggering mechanisms that favor body fat accumulation and insulin resistance in adult life [46]. Associations of events during intrauterine life or at delivery with gut microbiota composition in childhood have been demonstrated [47-49]. Despite the recognition that the microbiota profile results from an interaction between environmental and genetic factors [50], to our knowledge, investigations about its association with early life events and emergent cardiometabolic risk factors in young adults have not yet been reported. The ability of eating habits to change the gut microbiota

composition in the NutriHS could help to elucidate how dietary factors influence cardiometabolic risk.

Young adulthood, when preventive strategies could be more effective, is a unique moment for identifying early metabolic disturbances. The NutriHS cohort, by following undergraduates and graduates from Nutrition Colleges prospectively, has a great potential to enhance knowledge regarding the role of behavioral factors, especially related to diet and lifestyle, and underlying mechanisms of NCCDs. High-quality data are expected to be obtained from this stratus of the young Brazilian population. The age range of the NutriHS participants may confer less risk of recall bias, due to proximity to infancy and to more reliable information provided by parents and guardians present in their lives.

Innovative technologies in nutritional epidemiology, such the e-NutriHS, that deal with the entire process, from data gathering to analysis, is promising to overcome some of the logistical and financial feasibility constraints that can affect the conduction of such large-scale surveys. Furthermore, the broad reach of geographic areas can enhance participation rates. However, concerns about security, duplicate records, and sampling issues (selection bias) of online surveys should be raised [14,21]. Some of these concerns could be overcome, for example, through cryptography and security management of the database, screening scripts to check implausible answers and to detect and not allow saving duplicate registries [14,19,22,25]. Recent studies have reinforced that Web-based data collection represents a valid and suitable method [51-53].

Therefore, the initiative of building a website dedicated for this study, tailored to our local situation, should be emphasized. In addition to producing reliable data, the *e*-NutriHS proved to be easy to use, less costly and less time-consuming than paper-and-pencil collections. Furthermore, extra questionnaires can be included in the Web system, once the researchers decide to investigate additional concerns.

Since NutriHS implementation, users' satisfaction seems to be positive. Participants have found the system easy and practical to use. From 1,102 users (983 undergraduates and 119 graduates) the predominance of the female sex (94%) was expected and mean age of the sample is 25.1 (SD 7.4) years (unpublished data). Data on diet, physical activity, and others are ready for preliminary analysis. This scenario is in contrast with many epidemiological studies, which require a long period to get results. Another advantage of the *e*-NutriHS is related to the fact that participants receive a quick feedback about their health conditions.

Taking into consideration all these advantages, we believe that the NutriHS will contribute to elucidate the temporal sequence regarding some causal determinants and pathological effects, scarcely investigated in other cohort studies. Preliminary results (unpublished data) have fulfilled our expectation of establishing associations among events in the early stages of life, diet, gut microbiota, and circulating biomarkers, reinforcing the hypothesis of intrauterine programing interacting with environmental exposures to influence the risk profile for certain NCCDs, particularly for cardiometabolic diseases.

In summary, we conclude that the description of the NutriHS methodology, developed at FSP/USP, Brazil, is a relevant initiative to facilitate research in subsets of populations. In addition, the *e*-NutriHS proved to be a powerful and user-friendly tool for producing reliable information, which could also be used in the field of the public health. The combination of a friendly tool with the innovative purposes of NutriHS offers a remarkable resource for testing hypotheses, clarifying mechanisms of nutrition-related diseases and further planning of preventive programs.

LIST OF ABBREVIATIONS

NutriHS – Nutritionists' Health Study

NCCDs – non-communicable chronic diseases

ELISA – enzyme-linked immunoenzymatic assay

FSP/USP – School of Public Health, University of São Paulo

IPAQ – International Physical Activity Questionnaire

DXA - dual-emission x-ray absorptiometry

FUNDING

The study has not received external funding.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

LGDF, ITS, BAP and SRGF designed the study; LGDF, ITS, BAP and SRGF participated in the elaboration of the protocol. LGDF programmed the web-based system. LGDF and ITS have been participating in the acquisition of data. LGDF, ITS, BAP and SRGF drafted the manuscript.

All authors have read and have approved the final manuscript.

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ARTIGO 4

Validation of web-based self-reported anthropometric data in the Nutritionists' Health Study

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ABSTRACT

Objective: To evaluate the correlation and agreement of electronically collected data on weight and height with direct measurements, as well as the agreement of body mass index (BMI) categories in participants of the Nutritionists' Health Study (NutriHS). **Methods:** The NutriHS includes undergraduates of Nutrition courses; in its first cross-sectional phase, online questionnaires dealing with sociodemographic and health data, including self-reported body weight, height and BMI, were applied. Within a 10-week period, during a face-to-face visit, trained personnel took weight, height, and other measurements. The differences between self-reported and measured values, correlation (Pearson's coefficient) and agreement (Kappa statistic) were calculated, and Bland-Altman plot method was performed. **Results**: From 602 participants, 144 individuals (92.7% women, 24.4±6.7 years) were included in the validation sample. Strong correlations were found between the mean values of self-reported and measured weight (r=0,965, p<0.001), height (r=0.928, p<0.001) and BMI (r=0.944, p<0.001). Mean values of self-reported and measured values did not differ significantly (Student t test); mean differences for weight, height and BMI were -0.21 kg, 0.004 m and -0,22 kg/m^2, respectively. The Bland-Altman analysis showed good agreement between all parameters, while the occurrence of positive and negative differences was similar in cumulative survival assessment. Stratifying according to the nutritional status, the Kappa agreement among BMI categories was 0.77. **Conclusions:** We conclude that web-collected anthropometric data may represent a valid and suitable method for anthropometric data, especially when obtained from individuals related to the health area. Its utility and accuracy in other population samples need to be investigated.

INTRODUCTION

The major causes of morbidity and mortality of populations are related to the nutritional status. Obesity is the main nutritional disturbance nowadays and the most important risk factor for non-communicable diseases (NCDs) such as type 2 diabetes mellitus, hypertension, dyslipidemia, atherosclerotic cardiovascular disease and various cancers[4]. Anthropometric measurements and indexes have been largely employed to assess risk of diseases, as well to monitor interventions.

In epidemiological and clinical studies, the body mass index (BMI) has been the most used indicator of obesity, defined in adults by values equal or above 30 kg/m^2[,19]. Measurements of weight and height, necessary to calculate this index, are obtained using scales and

stadiometer. Despite simple and relatively inexpensive instruments, the data collection requires the presence of the individual and the trained anthropometrist, which may imply the transport of materials to fieldwork or the mobilization of the participants[16]. Due to such technical limitations, several surveys have employed self-reported anthropometric data. Particularly for large samples, self-reporting has represented an easy access to this kind of information, at a low cost and good quality if compared to direct measurements[1]. Due to implications of their results for clinical purposes, estimation of potential errors is very relevant.

Some inherent limitations related to self-reported information have been raised. Some investigators have verified an overestimation of height and an underestimation of weight that result in underestimation of BMI[11,13]. A misclassification of nutritional status and under-diagnosis of obesity could exclude individuals from an intervention needed. On the other hand, it has also been reported that lean individuals may overestimate their weight, falsely increasing their BMI[6,7,11,13]. These behaviors have been attributed in part to the wish of social acceptance, but also can be influenced by the data collection method.

Advances in information and communication technology have allowed obtaining standardized and reliable data in a quicker and more cost-effective way. The development of web-based system can ensure immediate construction of database, reduce costs, errors and minimize duplicate answers, what has motivated online surveys. Moreover, due to its interactive elements, the majority of respondents – particularly young people who were born during the Internet era – prefers web-based version to postal questionnaires or telephone interviews[15,17]. Also, feedback opportunities may increase participation rates and eliminate interviewer-associated bias. For our best knowledge, few studies were performed to access the validity of anthropometric data collected via web[3,10,14] and none was performed in Brazil.

The Nutritionists' Health Study (NutriHS) is a prospective web-based study, developed at the School of Public Health, University of São Paulo (FSP/USP), Brazil, including Nutrition undergraduates and graduates of the Brazilian population. The NutriHS has investigated the relationship of early-life events and daily habits with health outcomes in undergraduates and graduates from Nutrition courses (www.fsp.usp.br/nutrihs). The driving of the study is essentially based on self-reported information, collected via web. Also, biological samples have been obtained.

Since the NutriHS data collection is electronic, in the absence of interviewer, it is questionable whether and how these data agree with the measured values. In order to validate anthropometric data, the present study aimed at evaluating the correlation and agreement of

electronically collected data on weight and height with direct measurements in NutriHS' participants. Also, the agreement within categories of the nutritional status was tested.

METHODS

Details on the implementation of the NutriHS were reported elsewhere (unpublished data). Briefly, leaders of Brazilian universities were contacted and invited to visit the NutriHS website (www.fsp.usp.br/nutrihs). Undergraduates from Nutrition courses located in Sao Paulo state are eligible for its first phase launched in March 2014. Pregnancy is the exclusion criterion. A social network has been used to enhance compliance of participants. A web-based system named *e*-NutriHS (http://www.fsp.usp.br/nutrihs/index.html) has been employed to collect and analyze the NutriHS data. The institutional ethics committee approved the study.

For the purpose of this cross-sectional analysis, undergraduates who were registered at the website from March 2014 to August 2015, were included. Using a password at the NutriHS website, participants reach the link to the informed consent form. After consent, structured questionnaires regarding sociodemographic, lifestyle (physical activity and diet), medical data and family history are released for online filling. They are invited to schedule a face-to-face visit for physical examination and collection of biological samples at the FSP-USP health care center.

During the visit, participants undergo anthropometric measurements by trained personnel. Weight is obtained with individuals wearing light clothing and no footwear, placed in a standing position on a digital scale with 200 kg capacity, accurate to the nearest 100 g. Height is measured using a fixed stadiometer with a vertical backboard and movable headboard, accurate to the nearest 0.5 cm. BMI was calculated as weight in kilograms divided by height in meters squared.

The distributions of self-reported and measured variables were analyzed, and Student t test was used to compare their means. Differences between the self-reported and measured anthropometric values (weight and height, and the calculated BMI) were obtained. Pearson coefficient was used to examine correlation between self-reported and measured values. The Kappa statistic was employed to assess the magnitude of agreement between these values[18]. The agreement between these two groups of values was also analyzed by the Bland-Altman method and plot[2], as well as through survival analysis for BMI, as proposed by Luiz *et al.*[10]. Also, the agreement of the four BMI categories [obesity (BMI $\geq$ 30 kg/m^2), overweight (25

kg/m^2 ≥ BMI < 30 kg/m^2), normal weight (18.5 kg/m^2 ≥ BMI < 25 kg/m^2) and underweight (BMI < 18.5 kg/m^2)], defined according to the World Health Organization[19] was examined.

A p-value < 0.05 was considered significant. Analyses were performed in the Statistical Package for the Social Sciences®, version 16.0 (SPSS Inc, 2000).

RESULTS

A total of 602 participants fulfilled the web-based NutriHS questionnaires. Among them, 144 visited the health care center for the clinical assessments and constitute the validation sample (Table 1). There was a predominance of women, Caucasians and single participants in both subsets. The mean ages of the overall participants and of the validation sample were similar (26.5 ± 9.4 and 24.4 ± 6.7 years, p = 0.098), as well as the distribution of students in the semesters of the Nutrition course. The majority of participants from both subsets had a family income of one to five minimum wages (58.0% and 53.4%, respectively).

Self-reported and measured values of weight and height were strongly correlated (r = 0.965 and 0.928, respectively, p < 0.001), as well as the BMI calculated (r = 0.944, p < 0.001).

Table 2 shows the self-reported and measured anthropometric measurements and the differences between these values for the total sample and according to categories of the nutritional status. Non-significant differences between the two subgroups of weight, height and BMI values were, respectively, -0.21 kg, 0.42 cm and -0.22 kg/m^2 were detected. Considering the categories of nutritional status, underestimations of weight (-1.8 kg) and BMI (-1.02 kg/m^2) were observed in overweight participants (p < 0.001). The median lag time between self-reported and measured of the sample was 51 days.

The differences between self-reported and measured weight, height and the corresponding BMIs for the whole sample are plot in Figure 1. The values are within the 2 standard deviation limit of agreement, and the mean differences were close to zero (Table 2). Negative and positive differences occurred similarly regarding to the validation sample (log-rank test = 0.471), as shown in BMI survival agreement plot (Figure 2).

Stratifying the sample according to nutritional status, similar proportions of individuals in the categories of nutritional status, obtained from the self-reported and measured values, were observed (Table 3), Categories of BMI was concordant in 88.2% and such agreement was reinforced by a Kappa value of 0.77.

DISCUSSION

Our findings are relevant since they indicate that anthropometric data reported via a web-based system are appropriate to assess nutritional status of a stratus of the Brazilian population. At least for individuals aware of the importance of anthropometric measurements to evaluate diseases' risk, the strong agreement between web-based self-reported and measured weight and height, as well as the substantial concordance of BMI categories, support this statement. Considering that nutritional status-related morbidities represent a heavy burden for public health systems, facilitating means to get reliable anthropometric measurements are highly desirable.

Surveys have collected them using paper-and-pencil questionnaires, commonly requiring interviewer[5,12]. The use of technology and the Internet in nutritional epidemiology is still limited, but has the potential to overcome some logistical and financial feasibility constraints that affect the conduction of large-scale surveys, particularly in middle-income countries. Our study contributed to clarify some concerns raised on the validity of web-based surveys[9,14].

As far as we know, this is the first study that reports these analyses in a Brazilian sample. Studies conducted in the developed countries, similar strong correlations between self-reported and measured values have been reported for the three parameters (r_{height} = -0.98; r_{weight} = -0.99; r_{BMI} = -0.99), in individuals at similar age[14]. Our data are in agreement with those obtained for weight in a Swedish cohort3; also, the correlation coefficient magnitude is the same found in the Adventist Health Study[1], and in a recent web-based study involving Swedish adolescents[6].

Considering the three variables, weight, height and BMI, non-significant disagreement between self-reported and measured values was detected in the NutriHS, and the differences were lower as compared to those previously reported[1]. However, considering the overweight group, underestimations of weight and BMI were found. Similarly, in 2,513 participants of the Nutrinet-Santé, over-report for height and under-report for weight and BMI were detected, particularly among obese and overweight participants[9,14]. It is important to call attention that the latter study included volunteers but not nutrition undergraduates like in our study. The Adventist Health Study has not verified differences between web-based self-reported and measured weight [0.20 kg (-0.54 to +0.14)][1], but overestimation the height [1.57 cm (+1.31 to +0.02)] and, consequently, underestimation of BMI [-0.61 kg/m^2 (-0.75 a -0.46)]. Adventists' lifestyle is known to be healthy to which lower morbidity and mortality rates have been attributed[1]. This is somehow like our sample since it is composed of nutrition students. In

another study of youngsters attending high school in United States, a more pronounced disagreement was obtained using printed questionnaires[5]. These students underestimated their weight and BMI and overestimated height (-3.5 pounds, -2.6 kg/m^2 and 2.7 inches, respectively). Differences were also observed in a study with young Australian adults, namely over-reported height (1.36 cm, $p < 0.001$), under-reported weight (-0.55 kg, $p < 0.001$) and BMI (-0.56 kg/m^2, $p < 0.001$)[14].

Looking at the Bland-Altman plot and the intervals of agreement, our BMI values are indicative of a good agreement. Using similar methodology, in a sample of adolescents, a tendency of underestimation of higher values of BMI was found[6]. Furthermore, other studies verified that web-collected data were related to an under-report of weight at the higher values[3] or with symmetrical data over the mean BMI values[1,9]. Our findings regarding the survival agreement plot of similar distribution of negative and positive differences gave consistency to the previous analysis. These differ from the Adventist sample, in which a higher frequency of under-report in contrast to the over-report in the survival agreement plot was found[1].

The reasons for high agreement of data collected electronically in the NutriHS with the real anthropometric values may be in part related to the absence of an interviewer. Also, the consciousness of nutrition students about the importance of body composition for health should be considered.

Sample stratification according to the four BMI categories obtained from self-reported and measured values was a strategy to deepen the analysis of agreement. Coincident categories were seen for 88.2% and Kappa value emphasizes this substantial agreement. Despite slightly greater proportion of obese participants when anthropometric values were measured (6.9% versus 5.5%), this was not statistically significant. In a sample of adolescents, 86.4% were classified in the correct category of BMI[6]. In the Adventist Health Study 2, an almost perfect agreement (Kappa value 0.81) was obtained[1]. In French adults, an agreement of 93.2% and a Kappa index of 0.89 were found[9].

The high concordance of frequencies of participants in each BMI categories, for reported and measured BMI, reinforces the reliability of anthropometric data collected online. Experience of the NutriHS may be relevant for other researchers, since web-based system represents a fast and costless way of assessing nutritional status-related data in large-scale.

Our study has limitations, mainly concerning the very selected sample included, small sample size, as well as the high proportion of women. Due to selection bias, our conclusions

cannot be generalized. However, we call attention to the potential of the web in several research fields, mainly the nutritional epidemiology.

In summary, we conclude that web-collected anthropometric data may represent a valid and suitable method for anthropometric data, especially when obtained from individuals related to the health area. Its utility and accuracy in other population samples need to be investigated.

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TABLES AND FIGURES

Table 1: Baseline data of the NutriHS participants and the validation sample. Data in absolute numbers (percent in parenthesis) or mean ± standard deviation.

	NutriHS n = 602	**Validation sample** n = 144	**p value**
Sex			
• Men	34 (5.6)	12 (8.3)	0.217
• Women	574 (94.4)	132 (92.7)	
Age (years)	26.5 ± 9.4	24.4 ± 6.7	0.098
Reported racial group			
• Caucasian	410 (68.3	95 (66.0)	
• Afro-Brazilian	32 (5.3)	14 (9.7)	0.135
• Others	155 (25.9)	33 (23.0)	
• Not informed	3 (0.5)	2 (1.4)	
Graduation period			
• 1st – 5th semester	415 (68.99)	94 (65.3)	0.057
• 6th – 10th semester	187 (31.1)	50 (34.7)	
Marital status			
• Single	500 (83.1)	110 (76.4)	0.063
• Married, stable union or divorced	102 (16.9)	34 (23.6)	
Family income (minimum wage)			
• Up to 1	21 (3.5)	3 (2.1)	
• >1 - 5	349 (58.0)	77 (53.5)	
• 6 - 10	116 (19.3)	34 (23.6)	0.527
• >10	71 (11.8)	21 (14.6)	
• Not informed	45 (7.5)	9 (6.3)	
Work			
• Yes	400 (66.4)	89 (61.8)	0.293
• No	202 (33.6)	55 (38.3)	
Alcohol consumption			
• < 1 day to 6 days/week	203 (33.4)	46 (31.9)	0.741
• Never or < 1 day/month	405 (66.6)	98 (68.1)	
Smoking habit			
• Non-smoker	547 (90.9)	136 (94.4)	
• Current	29 (4.8)	6 (4.2)	0.232
• Past	26 (4.3)	2 (1.4)	

Chi-squared test used for categorical variables and Mann-Whitney for age.

Table 2. Mean values (standard deviation) of self-reported and measured anthropometric data and their differences stratified according to the nutritional status in the NutriHS validation sample.

	Self-reported	Measured	Difference	p-value
Total (n = 144)				
Weight (kg)	63.0 (13.5)	63.23 (13.7)	-0.21 (3.48)	0.886
Height (cm)	1.636 (0.069)	1.632 (0.067)	0.42 (2.54)	0.087
BMI (kg/m²)	23.4 (4.1)	23.7 (4.4)	-0.21 (1.40)	0.269
Underweight (n = 10)				
Weight (kg)	48.8 (5.8)	48.0 (4.9)	0.79 (1.69)	0.259
Height (cm)	1.66 (0.05)	1.65 (0.06)	8.00 (38.24)	0.514
Body mass index (kg/m²)	17.7 (1.5)	17.5 (0.6)	0.13 (1.04)	0.830
Normal weight (n = 91)				
Weight (kg)	58.1 (6.3)	57.7 (5.5)	0.41(3.54)	0.286
Height (cm)	1.62 (0.06)	1.62 (0.06)	0.77 (19.96)	0.738
Body mass index (kg/m²)	22.1 (1.9)	21.9 (1.6)	0.13 (1.16)	0.334
Overweight (n = 33)				
Weight (kg)	70.2 (7.7)	72.0 (7.1)	-1.80 (2.64)	<0.001
Height (cm)	1.65 (0.08)	1.63 (0.07)	10.61 (30.10)	0.057
Body mass index (kg/m²)	25.8 (1.3)	26.8 (1.2)	-1.02 (1.29)	<0.001
Obese (n = 10)				
Weight (kg)	97.8 (15.3)	99.4 (13.1)	-1.67 (4.80)	0.237
Height (cm)	1.69 (0.11)	1.68 (0.10)	10.00 (35.9)	0.441
Body mass index (kg/m²)	34.1 (4.9)	35.2 (4.9)	-1.07 (2.50)	0.210

Student t test used. Values were log-transformed for analysis.

Table 3. Number (percent) of individuals from the NutriHS validation sample in each category of nutritional status, percent of agreement and Kappa value considering the self-reported and the measured anthropometric values (n = 144).

	Self-reported	**Measured**	**Agreement (%)**	**Kappa**	**p**
Underweight	9 (6.3%)	10 (6.9%)	88.2	0.77	< 0.001
Normal weight	92 (63.9%)	91 (63.2%)			
Overweight	35 (24.3%)	33 (23.0%)			
Obese	8 (5.5%)	10 (6.9%)			

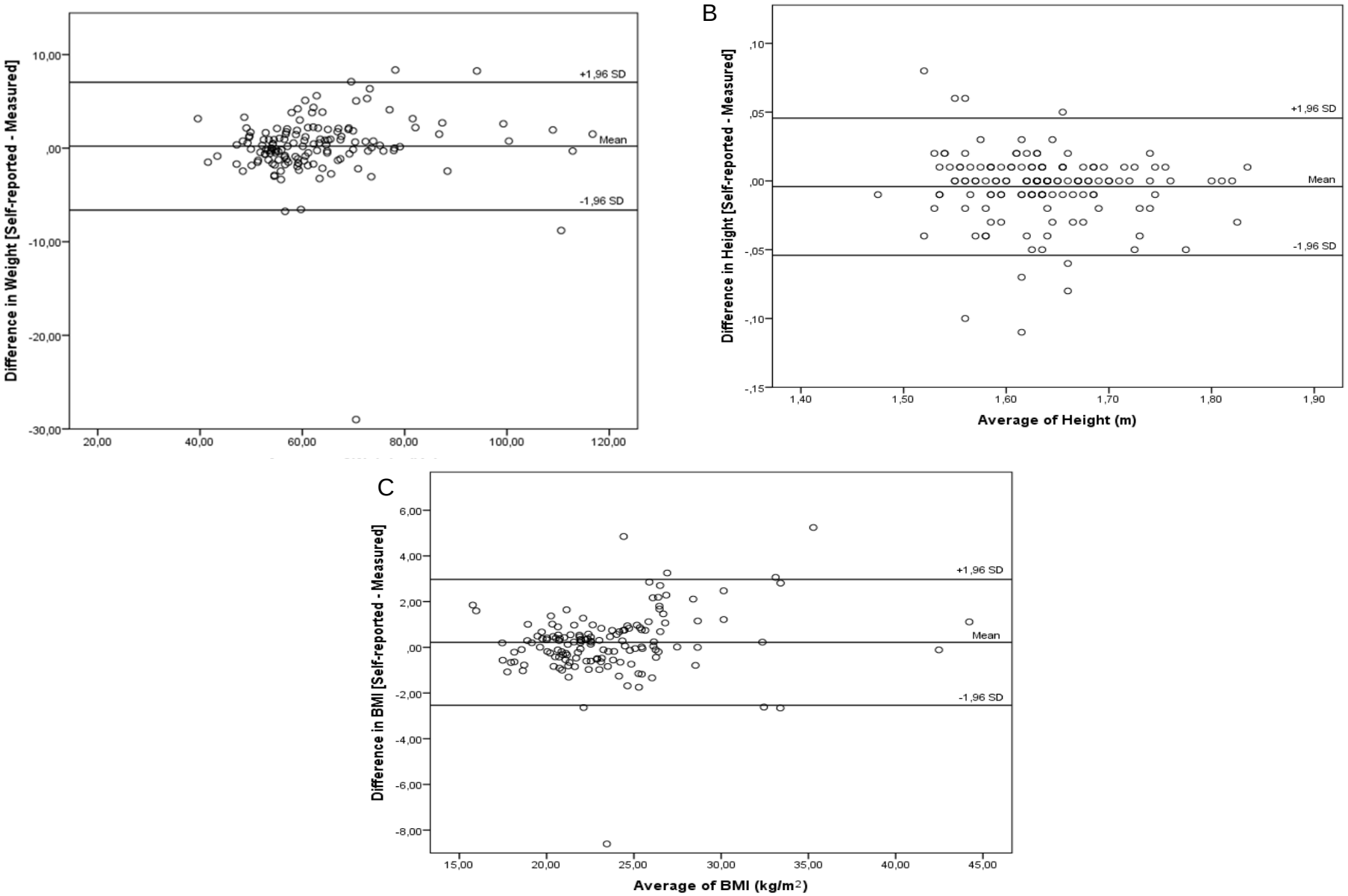

Figure 1 –Bland-Altman plot of the difference between self-reported and measured (y-axis) in relation to measured (x–axis) for weight (A), height (B) and body mass index [BMI] (C) in the NutriHS validation sample (n = 144).

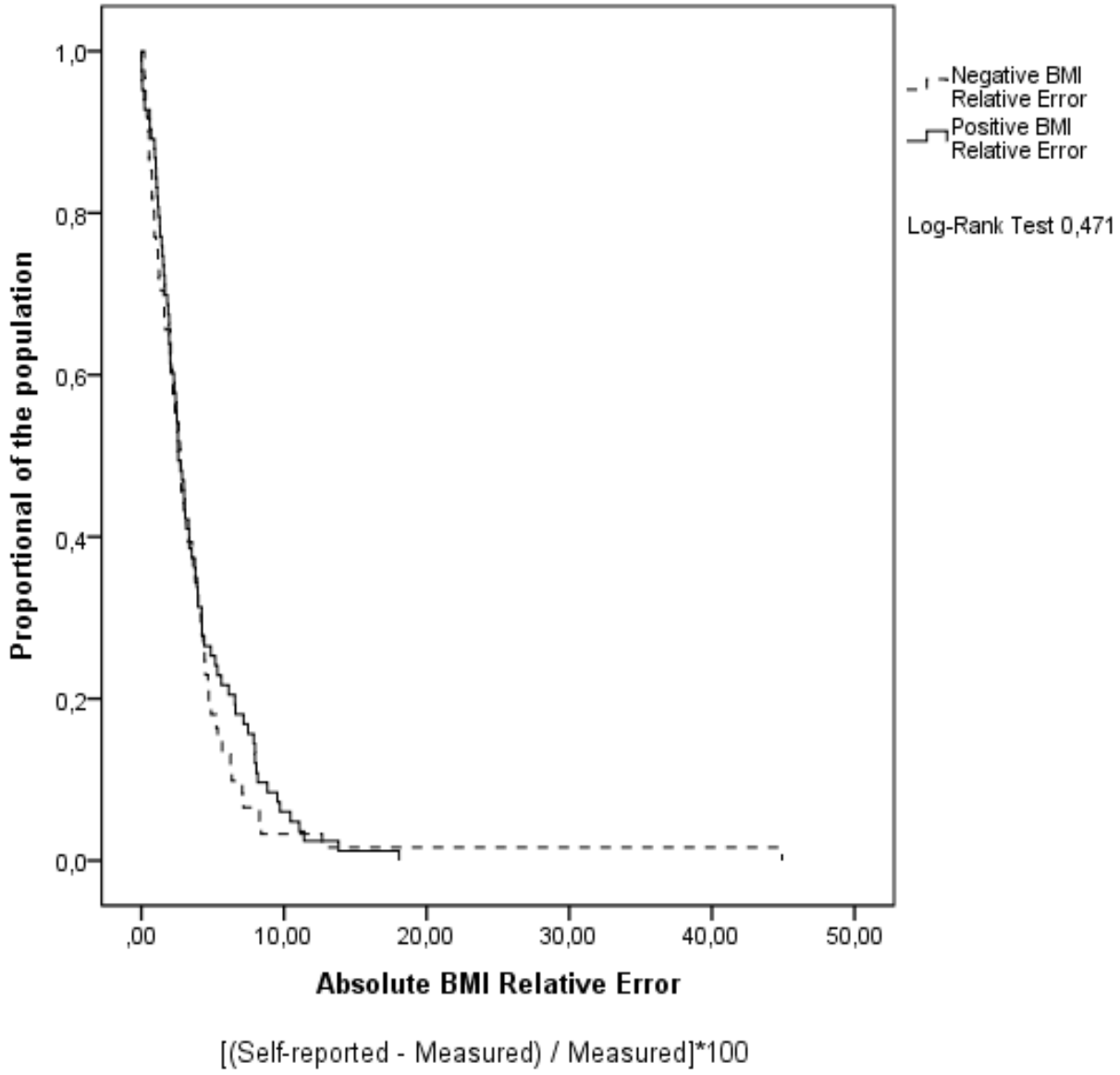

Figure 2 – Survival agreement plot for body mass index (BMI) in the NutriHS validation sample (n = 144). The x-axis shows the absolute difference between self-reported and measured body mass index (kg/m^2), and the y-axis shows the proportions of. Separate lines for negative difference and continuous line for positive difference.

ARTIGO 5

Nutrition literacy may improve dietary habits with impact in lipid profile

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ABSTRACT

Despite the demonstration of healthy lifestyle-induced benefits, sustained behavioral modifications to maintain adequate body weight are still a challenge. This study aimed to explore the effects of the exposure to nutrition knowledge and skills on dietary and anthropometric data, as well as biomarkers of glucose and lipid metabolism. This study included a sub-sample of 723 participants of the NutriHS who had completed all self-reported sociodemographic, physical activity and dietary data. Participants underwent anthropometric, blood pressure and laboratory measurements. Dietary data was used to calculate the food groups and the Health Eating Index (HEI) and lipids values to calculate the Castelli's Risk Index 1 (CRI) and the Atherogenic Index of Plasma (AIP). Participants were divided in three groups according to exposure to nutritional knowledge and compared using chi-square test, ANOVA or equivalent nonparametric test. P for trend was calculated for dietary data. Pearson coefficient was used to test correlations. Significant trends of lower energy, cholesterol and red meat and higher fruits and vegetables intakes were detected across the groups. Components of HEI, such as total fruit, total vegetables and refined grains were significantly higher in the graduated group. Also, graduates presented higher concentrations of HDL cholesterol and lower values of CRI and AIP. Both CRI and AIP were inversely correlated to fruits and vegetables intake and with the HEI component, refined grains. Our findings demonstrate that exposure to nutrition knowledge and acquired skills are associated with better dietary aspects and more beneficial lipid parameters in young healthy people.

BACKGROUND

Numerous studies have highlighted the importance of dietary habits combined with physical activity in reducing the incidence of chronic diseases, such as obesity, type 2 diabetes, and cardiovascular disease[1-7]. Their complications reduce quality of life, increase mortality and represent a heavy burden for public health systems. Despite the demonstration of healthy lifestyle-induced benefits, sustained behavioral modifications to maintain adequate body weight are still a challenge[1-7].

Strategies of nutritional education should include information on the role of nutrients and physical activity for health. However, knowledge in nutrition might not be enough to change dietary habits. Along with knowledge acquisition, the development of skills to analyze,

understand, and use the information to make appropriate nutrition decisions seems also relevant for this purpose[8-10].

A link between nutrition literacy and better management of chronic diseases has been reported[8-12], since the presence of diseases represents a motivation for changing lifestyle. In the absence of clinical disorders, there is little evidence that higher nutrition literacy is associated with healthier eating practices[10,11]. Sample skills and type of tools used in these investigations have limited to conclude on the role of exposure to knowledge in nutrition in improving dietary habits. Some of these limitations could be overcome when individuals were trained in this field.

The Nutritionists' Health Study (NutriHS) is a Web-based observational cohort study of undergraduates and graduates from Brazilian Nutrition Colleges, in which retrospective and prospective data are being gathered. Launched in 2014, the NutriHS aims at evaluating novel biomarkers and predictors of cardiometabolic outcomes[13]. Strengths of the NutriHS baseline sample are related to the inclusion of healthy participants and at different levels of nutrition literacy, which is considered a crucial feature for changing dietary habits and prevent nutrition-related diseases.

Several instruments have been proposed to assess food intake[14] and the quality of diet[15-19]. The Healthy Eating Index (HEI), created by Center for Nutrition Policy and Promotion, was updated to reflect the 2010 Dietary Guidelines for Americans. This has been considered an adequate tool to measure overall quality of food intake[20,21]. Higher HEI scores were associated with lower risk of obesity, diabetes mellitus and favorable lipid profile[22-24].

Abundant evidence has demonstrated the causal relationship of disturbances of lipid profile and cardiovascular outcomes[25-28]. More frequently, the deleterious role of LDL-cholesterol, as well as the protective role of HDL-cholesterol, has been reported in populations at cardiovascular risk[25-27]. Also, the impact of healthy diets has been more commonly examined in dyslipidemic individuals[28-32]. Improvement of lipid profile in normolipidemic samples is less explored and the prognostic significance deserves investigation.

Beyond the routine plasma lipids measurements, lipid indices obtained from combinations of these values have been proposed to identify at-risk individuals. The abilities of the Castelli's Risk Index 1[33] and the Atherogenic Index of Plasma[34] in reflecting the lipid profile atherogenicity have been reported and they may contribute to the prediction of cardiovascular events[35-40].

As nutrition literacy increases during Nutrition College, as well as after experimenting professional activity as nutritionist, we expected that the exposure to nutrition knowledge results

in improvement in surrogates of a healthy diet and circulating biomarkers. This sub-study of the NutriHS aimed to investigate the effects of growing knowledge and skills in the nutrition field on dietary and anthropometric data, as well as biomarkers of glucose and lipid metabolism.

MATERIAL AND METHODS

- **Study population**

For this cross-sectional analysis of the NutriHS, data from participants who were entered between March 2014 and March 2016 were considered. To be included in the NutriHS, individuals have to be 18 years and older, undergraduate or graduate from Nutrition colleges, and to have access to the Internet. Pregnancy was exclusion criterion. Details on the NutriHS implementation (http://www.fsp.usp.br/nutrihs/) and registration were reported elsewhere[41]. The Research Ethics Committee of the School of Public Health of the University of São Paulo (FSP-USP), Brazil, approved this study. Electronic consent was obtained from all participants.

A total of 1,163 registered volunteers started to fill online structured and validated questionnaires (Figure 1). A sample of 723 participants had completed all the data required for the current analysis until March 2016. Afterwards, they are invited to schedule a face-to-face visit for physical examination and collection of biological samples at the FSP-USP health care center.

- **Data collection and laboratory**

Self-reported sociodemographic data, smoking, alcohol consumption and other habits or health issues were obtained. Physical activity was assessed by the short version of the international physical activity questionnaire[42]. Dietary data were collected using a validated food frequency questionnaire[43]. The NutriHS web-based system has allowed the immediate transformation into daily macro- and micronutrients and food groups intakes, based on the USDA National Nutrient Database for Standard Reference[44].

To minimize inter-individual variation in consumption, nutrients were adjusted for 1,000 kcal as required for the HEI calculation[20,21]. Then, the number of servings per day of each group of foods was calculated based on 2010 recommendations of HEI Technical Report[20,21] and of the World Health Organization[1,2,45]. The HEI construction and the definition of cutoff points for the maximum, intermediate, and minimum scores for each component, which are also in accordance the Brazilian Cardiology Society[46]. In brief, the total score ranges from zero to one hundred. All

scores were calculated using servings or percentage of consumption from the daily intake per thousand calories. The components are: total fruits (0 to 5 points), whole fruit (0 to 5 points), total vegetables (0 to 5 points), beans and peas (0 to 5 points), whole grains (0 to 10 points), dairy (0 to 10 points), total protein foods (0 to 5 points), seafood and plant proteins (0 to 5 points), unsaturated-to-saturated fatty acids ratio (UnS/SFA) (0 to 10 points), refined grains (0 to 10 points), sodium (0 to 10 points), solid fats, alcohol and added sugar (0 to 20 points).

During the visit, participants underwent anthropometric, blood pressure and laboratory measurements by trained personnel. Height was measured using a fixed stadiometer and weight was taken with individuals wearing light clothes and no shoes on a digital scale with a capacity of 200 kg and accurate to the nearest 100 g. Body mass index (BMI) was calculated as weight in kilograms divided the square of the height in meters. Waist circumference was measured at the midpoint between the bottom of the rib cage and above the top of the iliac crest. Blood pressure was measured at rest in sitting position by an automatic blood pressure device (Omron HEM-712C, Omron Health Care, USA). Fasting blood samples were obtained for plasma glucose and lipoproteins determinations, which were performed immediately in the local laboratory using validated commercial kits. Lipids values were used to calculate the Castelli's Risk Index 1 (CRI) and the Atherogenic Index of Plasma (AIP) as follows: CRI = Total cholesterol / HDL cholesterol[33] and AIP = log Triglycerides / HDL cholesterol[34].

- **Statistical analysis**

Data are expressed as means and standard deviations, medians and interquartile intervals, or percentages. Normality of variables was verified with Kolmogorov-Smirnov test. When distributions were skewed they were log-transformed before analysis. To test the hypothesis that knowledge in nutrition (exposure) results in improvement of dietary habits, the graduation course was divided in two periods, and three groups were compared: I) first half (first to fifth semester) of the nutrition course, II) second half (sixth to tenth semester), and III) graduated. These groups were compared using chi-square test, ANOVA or equivalent nonparametric test. P for trend was calculated for dietary data. Pearson coefficient was used to test correlations between variables. Analyses were performed using Statistical Package for Social Sciences version 22.0 for Windows (SPSS Inc., Chicago, Illinois, USA). A p-value of < 0.05 was considered significant.

RESULTS

Mean age of the 723 participants was 24.9 ± 7.4 years, 94.1% were women, 69.3% Caucasians and 92.3% non-smokers. When individuals were stratified according to duration of the exposure to nutrition knowledge (Table 1), no difference regarding sociodemographic variables was detected except for occupational status. Significant lower values of total physical activity were detected in the graduated group in comparison to groups of undergraduates. Anthropometric data and blood pressure levels did not differ among the groups.

Analyses of dietary data (Table 2) indicated significant trends of decreasing energy (2,443 ± 1,191 *versus* 2,351 ± 976 *versus* 1,956 ± 957 kcal/day, p-trend < 0.001), cholesterol (327.7 ± 54.6 *versus* 271.3 ± 42.2 *versus* 227.9 ± 47.7 mg/day, p-trend < 0.01) and red meat (2.5 ± 1.5 *versus* 2.3 ±1.5 *versus* 2.0 ± 1.4 servings/day, p = 0.001) intakes from the first half of graduation to graduates, respectively. Intake of fruits and vegetables (4.9 ± 1.9 *versus* 5.1 ± 1.8 *versus* 6.4 ± 1.7 servings/day, p-trend = 0.004) were detected across the groups. HEI total score did not differ among the groups studied.

Components of HEI (Figure 2) such as total fruit (4.7 ± 0.9 *versus* 4.8 ± 0.7 versus 5.0 ± 0.1, p = 0.05), total vegetables (4.7 ± 0.9 *versus* 4.8 ± 0.6 *versus* 5.0 ± 0.1, p = 0.004) and refined grains (5.2 ± 3.0 *versus* 4.8 ± 2.7 *versus* 5.8 ± 3.2, p = 0.03) were significantly higher in the graduated group. Participants of the second half of graduation exhibited higher score for whole grains (7.4 ± 3.2 *versus* 8.4 ± 2.6 *versus* 7.7 ± 2.9, p < 0.001) and lower for UnS/SFA (4.9 ± 1.9 versus 4.4 ± 2.1 versus 4.7 ± 2.3, p = 0.05) than the others.

Laboratory data are depicted in Table 3. Mean HDL cholesterol concentration was significantly greater in the graduated group compared with undergraduates from the first and second half of the course (61.3 ± 11.3 *versus* 51.1 ± 11.6 and 56.6 ± 12.9 mg/dL, respectively, p = 0.001). Lower values of CRI (3.42 ± 0.93 *versus* 3.28 ± 0.79 *versus* 2.79 ± 0.46, p = 0.051) and AIP (0.47 ± 0.56 *versus* 0.40 ± 0.48 *versus* 0.01 ± 0.23, p = 0.043) were observed in the graduated group. Correlations of these data with dietary data were tested. AIP values were directly correlated to energy intake (r = 0.175, p < 0.05) and both CRI (r = -0.258, p < 0.001) and AIP (r = -0.184, p = 0.007) were inversely correlated to fruits and vegetables intake. Regarding HEI components, significant (p < 0.05) inverse correlations were observed between CRI with refined grains (r = -0.120) and dairy products (r = -0.127) and between AIP and refined grains (r = -0.176).

DISCUSSION

An important finding of our study was the evidence that knowledge and skills acquired during the Nutrition College seem to have a favorable impact on the undergraduates' personal life and further as a professional. Despite slight differences in food intake among the groups, some indicatives of a healthy diet, as well as lipid parameters improved from the very beginning of graduation to the graduated group. This was the case of increasing intake of fruits and vegetables and decreasing intakes of red meat and refined grains, which have been recommended by WHO[1,2,45]. Also, the observed associations of consumption of certain foods with HDL cholesterol and with lipid indices are suggestive of a cardioprotective role.

A peculiarity of our study was the inclusion of young and healthy individuals, who are being exposed to knowledge in nutrition and healthy behaviors. Previous studies had demonstrated benefits from general health-related knowledge[8,47,48]. The majority was conducted in clinical settings and addressed to manage disease-specific behaviors[49-53]. There is evidence that low health literacy was associated with outcomes such as obesity and its comorbidities[8,47,49,51,53-55], but the protection of high health literacy has been less investigated.

Some HEI components, such as total fruit, total vegetables and refined grains, reinforce that nutrition literacy and skills may result in personal benefits. Other studies previously reported associations of adequate health literacy with improved self-efficacy and self-management dietary behaviors[8-12,47]. The advantage of using the HEI was to provide a global measure of diet [quality19-21]. The HEI total score of 74.8 observed among undergraduates of the first half of the course is higher than the average of 50.5 described in Americans aged 19 and 30 years old[56]. This result was somehow expected since these participants might have previous interest in the field of nutrition, and might have a better lifestyle than the general population. Once a nutritionist, these abilities are necessary for the effectiveness of nutritional education and clinical practice.

Studies in different age groups have supported that low health literacy has also related to poor physical fitness and that increasing literacy may lead to increase physical activity[8,48]. We observed that the graduated group was less active, but still achieves the goal[1,2]. Our results could be explained, at least in part, by the different proportion of occupational status.

Although our study precludes analyzing cause-effect relationship, we investigated the correlation of dietary components and lipid parameters. Our findings reinforce that a healthier diet – characterized by high intake of fruits and vegetables and low intake of refined grains – could improve cardiovascular risk profile even within the normal range. Graduated group had significantly higher HDL-cholesterol and lower AIP, and marginally lower CRI. The relevance

of lipid parameters for the prediction of cardiovascular events has been widely reported[30-34]. In particular, the calculation of lipid indices, such as AIP and CRI, has shown to be useful when LDL cholesterol levels are below the target, facilitating the identification of at-risk individuals[27,30-40,57-59]. CRI was described as a more sensitive and specific index of cardiovascular risk than total cholesterol alone[33-40], while, more recently, elevated AIP values were strongly associated with small dense LDL particles, insulin resistance and major cardiovascular risk factors in adults[35,36-40]. Despite the aging effect on the graduated group, the nutritionists showed AIP values below 0.1, which have been considered at low risk. On the other hand, mean AIP of the undergraduates above 0.24 – proposed as high risk[57,58] – could suggest another utility for this index in the identification among "healthy people" those with increased risk. Such hypothesis deserves to be examined prospectively. Looking at the CRI values of each group, all of them were on target (less than 4.0) according to the Canadian working group on the management of dyslipidemia and the prevention of cardiovascular disease[59]. To our best knowledge, no one suggested that AIP could be more sensitive to differentiate cardiovascular risk level among low-risk individuals.

The cross-sectional design of our study hinders determination of causality and further longitudinal investigation is warranted. Also, our sample has an intrinsic selection bias that limits the generalizability of our results. However, this sample characteristic should have contributed to a high quality of the data collected. Another strength was our sample size. To our knowledge, this is the first study to investigate the association between nutrition literacy, nutritional status and biochemical profile in a young healthy population.

In summary, exposure to nutrition knowledge and acquired skills are associated with better dietary aspects and more beneficial lipid parameters in young healthy people. Our findings reinforce the importance of health literacy and nutritional education to promote adequate dietary practices that can be helpful for the prevention of a number of chronic diseases.

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Figure 1. Flowchart of the study enrollment and groups of participants compared.

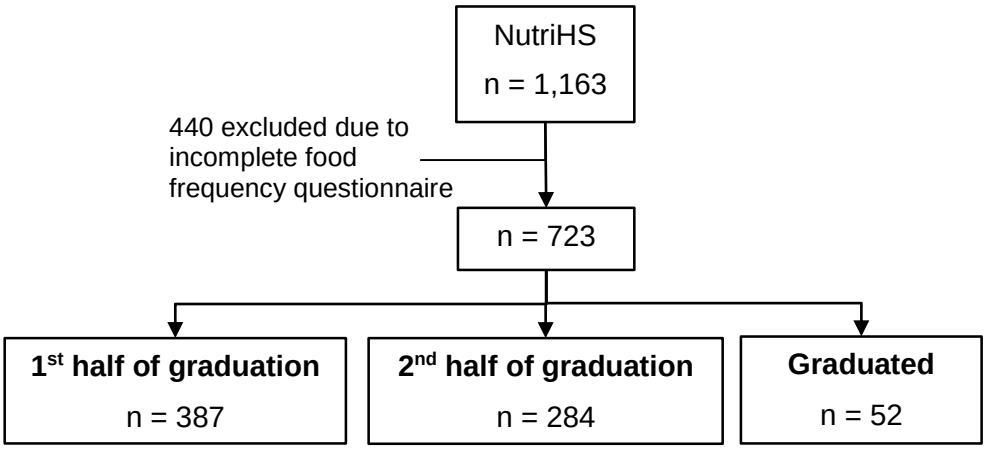


Table 1. Anthropometric measures, clinical data and physical activity level according to the duration of the exposure to nutrition knowledge. Data in percentage, mean ± standard deviation, or median (interquartile range in parenthesis).

	Undergraduates		**Graduated**	
	1st half	**2nd half**		**p**
	n = 387	n = 284	n = 52	**value**
Female sex (%)	92.2	94.0	97.4	0.084
Occupational status (% working)	51.8	74.7	75.9	0.001
Age (year)	23.7 ± 7.4	25.3 ± 6.5	29.2 ± 6.4	0.000
Total physical activity (min/week)	515 (196-975)	400 (150-790)	352 (106-765)	0.052
Time sitting (hours/week)	53.3 (39-70.7)	52.0 (39-68.2)	48.0 (33.2-61.9)	0.144
Body mass index (kg/m^2)	23.8 ± 3.6	23.3 ± 3.9	22.9 ± 3.5	0.481
Waist circumference (cm)	79.8 ± 13.1	76.9 ± 9.7	76.0 ± 6.4	0.215
Systolic blood pressure (mmHg)	113.3 ± 14.5	108.8 ± 12.8	109.4 ± 12.4	0.258
Diastolic blood pressure (mmHg)	73.2 ± 9.1	71.3 ± 8.9	72.3 ± 16.6	0.587

Continuous variables are presented as mean values ± standard deviations or median (interquartile range). ANOVA was used for clinical and biological variables and Mann-Whitney for physical activity level.

Table 2. Energy, macronutrient and food groups intake and HEI according to duration of the exposure to nutrition knowledge. Data in mean ± standard deviation.

	Undergraduates		**Graduated**		
	1st half	**2nd half**		**p**	**p for**
	n = 387	n = 284	n = 52	**value**	**trend**
Energy intake (kcal)	2,443 ± 1191	2,351 ± 976	1,956 ± 957†‡	0.001	0.000
Carbohydrates (%EI)	50.7 ± 8.3	53.2 ± 7.1†	53.4 ± 6.4	0.001	0.025
Protein (%EI)	15.3 ± 3.3	14.7 ± 2.6†	14.9 ± 2.4	0.142	0.505
Total fat (%EI)	33.4 ± 5.6	31.8 ± 5.1†	32.0 ± 4.8	0.000	0.091
Saturated FA (%EI)	11.9 ± 2.5	11.7 ± 2.4	11.5 ± 2.5	0.264	0.315
Unsaturated FA (%EI)	18.5 ± 3.6	17.4 ± 3.1	17.6 ± 2.9	0.000	0.060
Unsaturated-to-saturated FA ratio	1.5 ± 1.2	1.4 ±1.2†	1.5 ± 1.2	0.023	0.566
Cholesterol (mg)	327.7 ± 54.6	271.3 ± 42.2†	227.9 ± 47.7†	0.000	0.000
Total fiber (g)	25.1 ± 14.6	24.3 ± 12.4	23.2 ± 12.5	0.493	0.254
Fruits and vegetables (servings)	4.9 ± 1.9	5.1 ± 1.8	6.4 ± 1.7†‡	0.018	0.004
Dairy products (servings)	1.1 ± 2.2	1.2 ± 1.9	1.1 ± 2.1	0.214	0.988
Red meat (servings)	2.5 ± 1.5	2.3 ± 1.5†	2.0 ± 1.4†	0.000	0.001
Fish (servings)	0.9 ± 0.6	0.9 ± 0.5	0.9 ± 0.6	0.460	0.319
HEI total score	74.8 ± 9.1	74.8 ± 8.8	76.6 ± 8.0	0.381	0.177

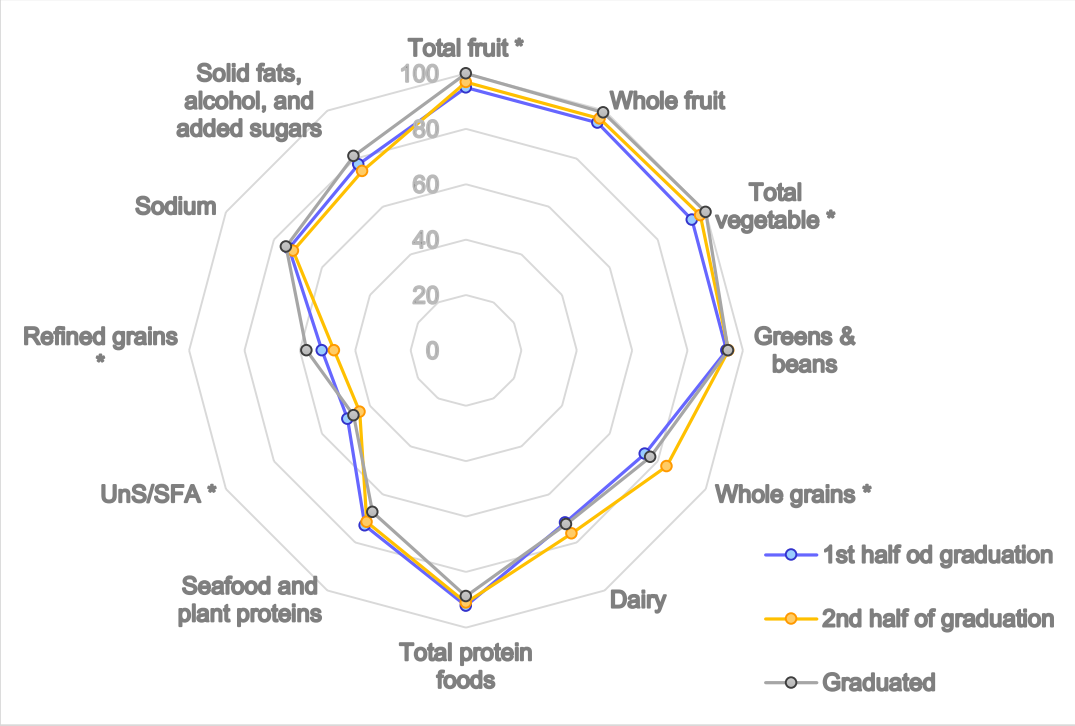
EI – energy intake; FA – fatty acids; HEI – Health Eating Index
Continuous variables are presented as mean values ± standard deviations
† $p < 0.05$ *versus* 1st, ‡ $p < 0.05$ *versus* 2st, using post hoc Bonferroni test to correct for multiple comparisons.
# Transformed for analysis.

Table 3. Laboratory data according to the duration of the exposure to nutrition knowledge. Data in mean ± standard deviation.

	Undergraduates		**Graduated**	
	1st half	**2nd half**		**p**
	n = 387	n = 284	n = 52	**value**
Fasting plasma glucose (mg/dL)	82.5 ± 9.1	82.8 ± 8.7	78.6 ± 9.2	0.642
Total cholesterol (mg/dL) [#]	169.0 ± 35.3	179.8 ± 35.8	167.8 ± 22.7	0.109
HDL cholesterol (md/dL)	51.1 ± 11.6	56.6 ± 12.9	61.3 ± 11.3[†‡]	0.001
LDL cholesterol (md/dL) [#]	99.7 ± 28.3	104.9 ± 32.7	92.1 ± 19.7	0.456
VLDL cholesterol (md/dL)	18.3 ± 10.4	18.3 ± 8.7	12.6 ± 3.3	0.161
Triglyceride (md/dL) [#]	91.0 ± 52.1	91.4 ± 43.8	62.7 ± 17.9	0.143
Castelli's risk index	3.42 ± 0.93	3.28 ± 0.79	2.79 ± 0.46[†]	0.051
Atherogenic index of plasma	0.47 ± 0.56	0.40 ± 0.48	0.01 ± 0.23[†]	0.043

Continuous variables are presented as mean values ± standard deviations or median (interquartile range). ANOVA was used for clinical and biological variables and Mann-Whitney for physical activity level.
[†] $p < 0.05$ *versus* 1st, [‡] $p < 0.05$ *versus* 2st, using post hoc Bonferroni test to correct for multiple comparisons.
[#] Transformed for analysis.

Figure 2. The Health Eating Index (HEI) components according to duration of exposure to the nutrition knowledge.



* $p < 0.05$ using ANOVA.
Total fruits – whole fruits and fruit juices.

7 CONSIDERAÇÕES FINAIS E CONCLUSÕES

Nossos achados revelam que o desenvolvimento de sistemas informatizados confere agilidade e precisão para coleta *on-line* e processamento de dados em estudos de epidemiologia. Em países em desenvolvimento, iniciativas semelhantes utilizando a Internet são escassas e quando se considera a inclusão de profissionais de saúde eram inexistentes.

A Internet é meio promissor para superar certas restrições logísticas e financeiras em pesquisa. A rápida evolução e propagação da TIC têm facilitado a obtenção de dados de forma mais ágil e padronizada e permitiu a criação do *e*-NutriHS. Esta ferramenta tem se mostrado amigável para o usuário e vantajosa para os pesquisadores. O preenchimento eletrônico dos dados, além de reduzir custos, erros e duplicidade de informações, gera um BD com informações confiáveis e já prontas para a análise estatística. Assim, o desenvolvimento de pesquisas baseadas na web, com potencial de identificar fatores de risco, em locais com recursos limitados, é altamente desejável.

Dado o crescente reconhecimento da importância da abordagem do curso de vida para entender os determinantes de DCNTs, o NutriHS foi projetado para ser um estudo de coorte em que os dados retrospectivos e prospectivos estão sendo coletados. A inclusão de adultos jovens, momento oportuno para a identificação de distúrbios metabólicos iniciais, tem grande potencial de acrescentar conhecimento sobre o papel dos fatores comportamentais, especialmente relacionados à dieta e estilo de vida, e sobre mecanismos de DCNTs. A faixa etária do NutriHS é conveniente não apenas por viverem na era da Internet, mas também pelo menor risco de viés de memória dos participantes e de seus pais ou responsáveis.

Um diferencial da coorte do NutriHS será a análise do impacto do estilo de vida, estado nutricional em diferentes fases da vida inclusive a intrauterina, e a microbiota intestinal na ocorrência de desfechos cardiometabólicos. O NutriHS já está fornecendo hoje dados promissores que podem contribuir para aprofundar o conhecimento sobre a influência de eventos iniciais da vida na composição corporal e no estado de inflamação subclínica de adultos jovens.

Benefício da construção de um *site* dedicado para este estudo – o *e*-NutriHS – e qualidade na produção de informação são comprovados pelo achado de forte concordância entre os dados antropométricos autorrelatados e aferidos para avaliar o estado nutricional. Adicionalmente, considerando a hipótese de que conhecimento em nutrição se associa

melhores hábitos de vida e perfil de risco cardiometabólico, achados do NutriHS quanto a parâmetros indicativos de uma alimentação saudável e lipídicos reforçam a importância da informação e do papel da educação nutricional.

Nossos achados revelaram que nutricionistas, em detendo maior conhecimento e prática em nutrição e saúde, apresentaram parâmetros sugestivos de estilo de vida mais saudável e melhor perfil lipídico do plasma. Interpretamos que seu maior consumo de frutas, verduras e legumes e menor de alimentos refinados, devido às características nutricionais, poderiam estar contribuindo para condições metabólicas (particularmente lipídica) mais adequadas dos nutricionistas. Em teoria, a manutenção de hábitos dietéticos mais saudáveis no longo prazo poderia beneficiar seu perfil de risco cardiometabólico.

Apesar de nossa amostra apresentar concentrações normais de lípides, os estudantes de nutrição comparados aos nutricionistas apresentavam índices lipídicos de risco mais altos. Investigações sobre o prognóstico desta faixa "normal-alta" destes índices foram pouco exploradas. Há indício no nosso estudo que a aplicação dos conhecimentos sobre nutrição e saúde – por parte de indivíduos que transitam no campo da nutrição – possa ser útil ao perfil lipídico mesmo dentro da faixa de normalidade. Delineamento adequado é necessário para investigar esta hipótese.

Em conclusão, o desenvolvimento do *e*-NutriHS proporcionou a rápida implementação do NutriHS, gerando dados de alta qualidade e com baixo custo. Há evidências de que informações coletadas eletronicamente são confiáveis. A exposição ao conhecimento em nutrição por indivíduos da área parece impactar positivamente no seu hábito alimentar e perfil lipídico. Contudo, o seguimento dos participantes do NutriHS é necessário para comprovar hipóteses aqui levantadas.

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9 ANEXOS

ANEXO 1 – Projeto de documentação do *e*-NutriHS

ANEXO 2 – Termo de Consentimento Livre e Esclarecimento

Estudo de Saúde de Nutricionistas
"Conhecendo nutrição, gerando saúde"

SAIR

Termo de Consentimento Livre e Esclarecimento

Prezado aluno,

Este termo de consentimento livre e esclarecido (TCLE) tem como finalidade esclarecê-lo a respeito dos objetivos, riscos e benefícios do presente estudo. Além disso, destaca que sua participação é livre e que sua privacidade será garantida em qualquer circunstância.

Ao clicar no botão "Consinto em participar" certifico que, após convenientemente esclarecido pelo pesquisador e ter entendido o que me foi explicado, aceito participar e concordo com os termos destritos no TCLE.

Título: Estudo de Saúde de Nutricionistas - Fase 1 (ESNutri 1) da FSP-USP

Este Termo descreve a finalidade, os procedimentos, benefícios, riscos, desconfortos e advertências deste estudo. É importante para sua decisão sobre a participação no estudo que leia e compreenda as explicações dos procedimentos propostos abaixo.

Objetivo: Avaliar a associação de variáveis de composição corporal com biomarcadores de risco cardiovascular; analisar a composição da microbiota intestinal e sua associação com hábitos alimentares e com biomarcadores de risco cardiovascular.

Benefício: Para indivíduos incluídos no estudo será a investigação de fatores de risco e/ou proteção nutricionais para doenças crônicas não-transmissíveis (DCNT), bem como fatores consagrados e os pouco explorados na literatura.

Sua participação inclui:

- Responder questionário sobre saúde, ingestão alimentar, crenças e atitudes sobre obesidade via internet;
- Realizar avaliação antropométrica, de pressão arterial e da composição corporal pelo densitômetro de dupla emissão com fonte de raio-X (DXA). Este exame é um método inócuo e preciso e sua realização leva 15 minutos.
- Coleta de 30 ml de sangue com material descartável e pessoal treinado, após 12 horas de jejum;
- Obtenção de amostra de fezes.

A coleta de sangue e o recebimento da amostra de fezes serão realizados no Centro de Saúde da FSP, em dia e hora pré-agendados.

Risco: Este estudo é considerado de risco mínimo. A antropometria, bem como o DXA, não causam qualquer desconforto e não requerem preparo prévio. A coleta de sangue pode raramente gerar um pequeno hematoma (manchas roxas) no local de punção, que, em geral, desaparecem após 3 a 5 dias.

Não haverá riscos para a integridade física, mental ou moral da sua pessoa. Todas as informações coletadas serão de caráter confidencial e utilizadas somente para fins científicos descritos no protocolo desta pesquisa, sem qualquer identificação pessoal.

O consentimento está sendo pedido exclusivamente para a participação neste estudo. É garantida e respeitada a privacidade na divulgação dos resultados da pesquisa, e não haverá sua identificação.

Liberdade: É garantido o direito de desistir a qualquer momento da participação nesta pesquisa, sem qualquer prejuízo.

Informações para Contato em Caso de Intercorrências

Estaremos à disposição para informá-lo(a) sobre os procedimentos, riscos e benefícios decorrentes da pesquisa, ou qualquer outra dúvida sobre o estudo.

Caso haja quaisquer dúvidas ou perguntas relativas ao estudo, você poderá entrar em contato em qualquer momento com a Dra. Isis Tande da Silva e Dra. Sandra Roberta Gouvea Ferreira.

Telefones: 3061- 7705/7701 ou pelo e-mail: isistande@usp.br/nutrihstudy@gmail.com

Ou com o Comitê de Ética em Pesquisa - COEP/FSP
Telefones: 3061-7779 ou 3061-7742 e-mail: coep@fsp.usp.br
Endereço: Av. Dr. Arnaldo, no 715, Cerqueira César, São Paulo-SP, CEP:01246-904

☐ Declaro que li e aceito todos os itens do termo de consentimento acima.

Voltar

Salvar

Av. Dr. Arnaldo, 715
Cerqueira Cesar, São Paulo - SP

Desenvolvido por LDFolcinetti

Na rede:

Background picture by Darren Hester

ANEXO 3 – Parecer consubstanciado CEP/FSP/USP

FACULDADE DE SAÚDE
PÚBLICA DA UNIVERSIDADE
DE SÃO PAULO

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: ESTUDO DE SAÚDE DE NUTRICIONISTAS - FASE 1 (ESNUTRI 1) DA FSP-USP
Pesquisador: Isis Tande da Silva
Área Temática:
Versão: 2
CAAE: 12455313.8.0000.5421
Instituição Proponente: Faculdade de Saúde Pública da Universidade de São Paulo - FSP/USP
Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 257.513
Data da Relatoria: 19/04/2013

Apresentação do Projeto:
ndn

Objetivo da Pesquisa:
ndn

Avaliação dos Riscos e Benefícios:
ndn

Comentários e Considerações sobre a Pesquisa:
ndn

Considerações sobre os Termos de apresentação obrigatória:
ndn

Recomendações:
ndn

Conclusões ou Pendências e Lista de Inadequações:
Pendências atendidas. Pela aprovação.

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

Endereço: Av. Doutor Arnaldo, 715
Bairro: Cerqueira Cesar **CEP:** 01.246-904
UF: SP **Município:** SAO PAULO
Telefone: (11)3061-7779 **Fax:** (11)3061-7742 **E-mail:** coep@fsp.usp.br

FACULDADE DE SAÚDE
PÚBLICA DA UNIVERSIDADE
DE SÃO PAULO

Considerações Finais a critério do CEP:

SAO PAULO, 26 de Abril de 2013

Assinador por:
Claudio Leone
(Coordenador)

Endereço: Av. Doutor Arnaldo, 715
Bairro: Cerqueira Cesar **CEP:** 01.246-904
UF: SP **Município:** SAO PAULO
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Possui formação em técnico em informática pela Escola Técnica de São Paulo (2012), graduação em nutrição pela Universidade de São Paulo (2008) e mestrado em Nutrição em Saúde Pública pela Faculdade de Saúde Pública (2012). Atualmente é doutoranda pela Faculdade de Saúde Pública -USP. Tem experiência na área de Nutrição, com ênfase em Nutrição, atuando principalmente nos seguintes temas: risco cardiometabolico, consumo alimentar, inflamação, resistência à insulina e estilo de vida; e alguma experiencia na área de Informatica. **(Texto informado pelo autor)**

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Endereço Profissional

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Formação acadêmica/titulação

2012

Doutorado em andamento em Nutrição em Saúde Pública.
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Orientador: Sandra Roberta Gouvea Ferreira Vivolo.
Bolsista do(a): Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, CAPES, Brasil.
Palavras-chave: banco de dados; software; sistema compudadorizado; Nutrição.
Grande área: Ciências da Saúde
Grande Área: Ciências Exatas e da Terra / Área: Ciência da Computação / Subárea: Sistemas de Computação / Especialidade: Software Básico.
Setores de atividade: Atividades de atenção à saúde humana.

2010 - 2012

Mestrado em Nutrição em Saúde Pública.
Faculdade de Saúde Pública - USP, FSP, Brasil.
Título: Análise da associação do consumo de frutas, legumes e verduras e de micronutrientes com marcadores de estado oxidativo, inflamatório e de resistência à insulina em indivíduos de risco cardiometabólico.,Ano de Obtenção: 2012.
Orientador: Sandra Roberta Gouveia Ferreira Vivolo.
Bolsista do(a): Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, CAPES, Brasil.
Palavras-chave: antioxidantes; diabetes mellitus; estresse oxidativo; Qualidade de vida; risco cardiometabolico.
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2003 - 2008

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