Food Control 141 (2022) 109198

Contents lists available at ScienceDirect

Food Control

journal homepage: www.elsevier.com/locate/foodcont

Knowledge, attitudes and practices model in food safety: Limitations and methodological suggestions

1. Introduction

Not surprisingly, a significant number of contributors to Food Control focus on addressing food safety practices and food handling concerns because of the risk to consumer health from unsafe food. Therefore, we would like to take this opportunity to discuss with Food Control readers about studies that address food safety practices and related cognitive factors. Researchers around the world are dedicated to find solutions and strategies to improve food safety on many levels. This is particularly important given the global burden of foodborne illness on health, economies, and food systems (Havelaar et al., 2015; World Health Organization, 2019).

In this sense, the Knowledge, Attitudes and Practices (KAP) model is one of the most widely used theories to explain and study food safety practices (Zanin et al., 2017). In recent years, numerous studies based on this theory have been published, many of them in Food Control (Al-Kandari et al., 2019; Letuka et al., 2021; Ncube et al., 2020; Nyokabi et al., 2021; Siddiky et al., 2022; Sirichokchatchawan et al., 2021; Soon et al., 2020). There are more than 250 articles in the *ScienceDirect* database that use the KAP model to explain food safety. The KAP model, developed in the 1950s, is commonly used by researchers to examine the cognitive aspects of food handling. The theory assumes that individuals who handle food will adopt positive food safety practices if they have the knowledge and positive attitudes (Baş et al., 2006). The simplicity of understanding food safety practices and the ease with which the theory can be applied may explain its popularity.

In applying the KAP model, some authors argue that knowledge can promote a positive attitude and that attitude, in turn, shapes practice (e.g., Ahmed et al., 2021; Hashanuzzaman et al., 2020). However, many authors criticize the idea as knowledge alone seems to be insufficient for predicting attitudes and practices (da Cunha et al., 2014; Elobeid et al., 2019; Gruenfeldova et al., 2019; Soon et al., 2020; Zanin et al., 2017). Even though some of these criticisms date back more than 20 years (Ehiri et al., 1997), the KAP model is still a very popular approach to food safety studies today. So, this commentary paper is designed to offer some thoughts on using this model to encourage readers to improve the design of their food safety experiments. Based on critical reflection and the data available in the literature, this commentary aims to discuss some of the limitations of using the KAP model in food safety studies. We will also discuss some additional perspectives and make some suggestions for future research in the field.

2. Limitations of the KAP model

While several limitations could be considered around the KAP model, we will focus on four major limitations, particularly for food handling research. Specifically, the paper briefly highlights and discusses the application of the KAP model based on: 1) the theoretical rationale; 2) the modeling of the studies; 3) practice evaluation; and 4) scoring and scaling. These limitations were selected based on the authors' previous experience on this topic and other studies that discuss the limitations of the model.

The first limitation of the KAP model is its rationale, as it attempts to explain a complex phenomenon such as safe food handling with only two variables: knowledge and attitudes. Knowledge is "the information, understanding, and skills that one acquires through education or experience" (Oxford Dictionary, 2022). Food safety knowledge in such studies is usually measured by questions aiming to measure objective knowledge. The correct answers are then converted into a knowledge score. Attitude is "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 2007, p. 582). Attitude is generally measured using several attitudinal responses about food safety (e.g., "food safety is an important part of my job") or safe food handling behaviors (e.g., "It is important to wash my hands with soap for at least 20 seconds before handling ready-to-eat food is important"). Such statements are measured using agreement scales. Based on those definition, the model assumes that people behave 'rationally' after acquiring knowledge and ignores the influence of heuristics on behavior (Ehiri et al., 1997). So, the model disregards several well-known cognitive factors that affect health behavior, such as risk and benefit perceptions, beliefs, motivation, subjective norms, locus of control, habit, and many others (de Freitas et al., 2019; Mullan et al., 2015; Zanetta et al., 2022). The KAP model has not evolved over the years and still does not account for important aspects of behavior change discussed in other theories such as the Transtheoretical Model (Byrd-Bredbenner et al., 2008), the Theory of Planned Behaviour (Mucinhato et al., 2022; Mullan & Wong, 2010) and the Health Belief Model (Wang et al., 2021). Thus, assessing the KAP variables alone does not appear to be sufficient to understand food safety behavior without the addition of other factors.

Secondly, the modeling of the KAP studies appeared to be problematic and conflicting. Scholars have modeled the three constructs (i.e., knowledge, attitudes, and practices) in studies in many ways, suggesting that the KAP model lacked a definitive process for its application. Fig. 1 shows the three most common approaches to using KAP theory in food safety studies. In model 1A, food safety practices are predicted by knowledge and attitudes, with a positive correlation between knowledge and attitudes. Model 1B is a correlation model in which all variables have a positive correlation among themselves. The results using these models are inconsistent. Some studies found no correlation or effect of knowledge on food safety practices (Aquino et al., 2021; Ko, 2013; Pacholewicz et al., 2016; Rebouças et al., 2017; Soon et al., 2020; Vo

https://doi.org/10.1016/j.foodcont.2022.109198
Received 10 May 2022; Received in revised form 15 June 2022; Accepted 16 June 2022
Available online 19 June 2022

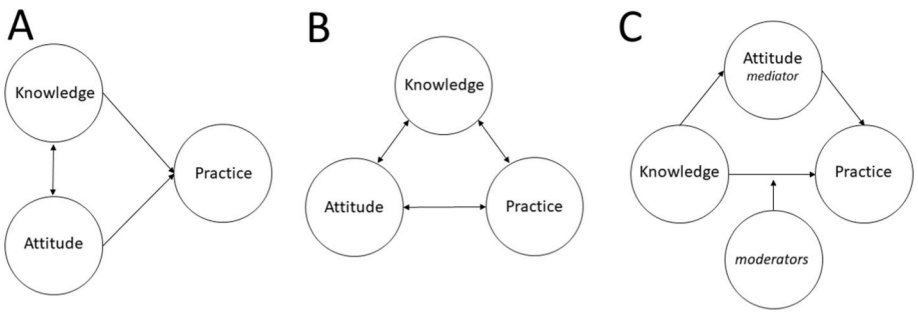

Fig. 1. Examples of different approaches used to test KAP theory in food safety studies.
One-head arrow = direct effect; two-headed arrow = correlation.

et al., 2015) or no effect of attitudes on practices (Akabanda et al., 2017; da Cunha et al., 2014; Mohd Azaman et al., 2016; Siddiky et al., 2022). On the other hand, positive correlations or effects among the variables (Abdul-Mutalib et al., 2012), including some weak correlations (Pearson$_r$ or Spearman$_{rho}$ < 0.50) (Abdullah Sani & Siow, 2014; Al-Kandari et al., 2019; Al-Shabib et al., 2016; Mihalache et al., 2022; Tan et al., 2013) were observed. Several possible explanations could explain these incongruent results. Knowledge and attitudes may be important cognitive aspects that affect practice, but translating knowledge into practice or positive attitudes is difficult because multiple factors mediate and moderate this relationship, such as personal factors (*e.g.,* self-efficacy, attitudes, education) (Ko, 2013; van Rijen et al., 2021; Zanin, Stedefeldt, et al., 2021), organizational factors (*e.g.,* culture and climate, communication, engagement, lack of time) (Clayton et al., 2002; de Andrade et al., 2021; Taha et al., 2021; Zanin, Stedefeldt, et al., 2021) and structural factors (*e.g.,* lack of or inadequate placement of facilities and equipment) (Mihalache et al., 2022; Soon & Baines, 2012; Webb & Morancie, 2015).

A model encompassing mediation and moderation (Model 1C) might be a better approach, especially when different cognitive and organizational variables are included. A mediator effect exists when a third variable stands between two other related constructs and helps explain the effect, *i.e.,* a mediator facilitates the relationship between two other constructs (Hair et al., 2009). A moderator is a third variable that can change the relationship between two different variables, (*i.e.,* the moderator can increase or decrease the strength of a relationship between two variables) (Hair et al., 2009). As examples of moderators we could cite: experience, physical structure, motivation, job satisfaction, job crafting, and many cognitive and organizational factors. Note that one variable could be tested to moderate any other effect (i.e., not just between knowledge and practice, as shown in Model 1C). Other approaches, such as extending the KAP model by adding new variables, are also possible.

The third limitation we would like to focus on is the measurement of practices, a common problem with studies measuring actual practices and behavior. Some studies have highlighted the discrepancy between food safety self-reported and observed practices (Da Cunha et al., 2019; Zhang et al., 2022). When evaluating their practices, food handlers and consumers attribute their success to an internal locus of control (de Freitas et al., 2019), which is strongly influenced by knowledge and risk perception (Da Cunha et al., 2019). Therefore, the self-reported practice appears to be overestimated due to biases such as self-assessment bias (Da Cunha et al., 2019), social desirability (Scholderer & Veflen, 2019), memory and recall bias (Hansen et al., 2022), and interviewer bias when using face-to-face surveys (Wynder, 1994). In this case, self-reported practice is weakly correlated with actual practice and cannot be used interchangeably. However, only a few authors (see, for example, Da Cunha et al., 2019; Zhang et al., 2022) treat the self-reported practice as a cognitive variable. The problem regarding practices is compounded when conducting a KAP survey. Self-reported practices are usually rated using a frequency scale, e.g., 1 - never to 5 - always (Abdullah Sani & Siow, 2014; da Cunha et al., 2014; Luo et al., 2019; Tan et al., 2013). Perceptions of what is "never" or "always" can vary, e.g., "How often do you wash your hands?" - For some food handlers, "always" means washing their hands once a day. Although the responses are ranked, however, the distance between the responses may vary. The differences between "sometimes," "often," and "always" on a frequency scale are not equal (Sullivan & Artino, 2013). Therefore, it is challenging for the respondent to rationalize these frequency statements. Some suggestions for measurement practice are discussed further.

A fourth problem is the measures' lack of reliability and validity. Subjective knowledge, attitude, and self-reported practices are constructs (*i.e.,* they need to be measured using multiple items or indicators). Even when questionnaires and known scales are used, these constructs may have low reliability, so it is impossible to assume the measurement is accurate. Few studies report the assessment of the reliability of the measurement, whether measured using Cronbach's alpha, composite reliability, or test-retest reliability (e.g., Abdullah Sani & Siow, 2014; Ko, 2013). We strongly recommend that researchers assess the reliability of each construct. In addition to reliability, validity is also important. Many studies conflate the concepts, resulting in invalid constructs. For example, self-reported practice questions are often more specific than attitudes questions. They may focus on a particular action performed in a specific time period or context, such as using a thermometer for cooking meat. In contrast, attitude measures are often more general, (e.g., "food safety is an important part of my job"). The attitude measures suggest a large time span and refer to many contexts in which a person may act to prevent foodborne illness if they recognize, understand, and agree that such practices are important.

3. Suggestions and future research

This section presents and discusses some suggestions for future research using the KAP model. Despite the limitations highlighted in using the KAP model in food safety studies, its constructs are not without some merit. Knowledge and attitude will always be relevant constructs for food safety practice. Therefore, finding different ways to work with these constructs will help researchers better predict and explain food safety behaviors.

Although the KAP model has been used extensively in food safety research, studies on its extensions remain limited. Kwol et al. (2020) is an excellent example of how to extend the approach. This study hypothesized a model to test knowledge and attitudes predicting different safety practices: personal hygiene, kitchen hygiene, and disease control measures. Including other theories and constructs could increase the model's explanatory power. Another example is the inclusion of a safety climate. Organizational and safety climate are antecedents of safety knowledge and safety motivation (Neal et al., 2000). Safety knowledge and motivation, in turn, could increase safety compliance and participation in the relevant practices (Vinodkumar & Bhasi, 2010). These aspects are extremely relevant since the role of food safety climate and culture in the practices of food handlers is already well established in the

literature (de Andrade et al., 2020; De Boeck et al., 2018). In Ko (2013) study, the attitude was included as a mediator between knowledge and practice. This is an interesting way to also extend the KAP model. Thus, attitude is necessary to shape knowledge into practice. Aquino et al. (2021) improved the model by adding training as a moderator while studies such as Brannon et al. (2009) and Webb and Morancie (2015) also reported on level of experience and its relation to food safety knowledge. Identifying and testing mediators and moderators of food safety practices adds to the model's explanatory power and could Improve/enhance the prediction of food safety behaviors. However, this is with the provision that the rationality of including new variables should be fully argued and the relationship between the newly added variables and original KAP constructs should be carefully analyzed.

Because of biases in self-reports of behavior, it is advisable to evaluate actual practice by observation. Observation is also known to have its limitations, such as the Hawthorne effect (McCambridge et al., 2014), although this can be minimized by discarding the first 30 minutes of notes; mixing with co-workers by wearing similar protective clothing; not informing participants what specific actions were observed (Clayton & Griffith, 2004) and using smartphone technology for discrete observation (Behnke & Seo, 2015; Soon, 2019). The observed practice appears to be less biased than self-reported practice. Nevertheless, measuring behavior through observation is not always possible, such as for consumers who handle food at home. Therefore, improved measures of self-assessment that correlate well with observation need to be developed. Studies comparing good self-reported behavior with observed behavior show high correlations (e.g., Milton and Mullan (2012)). Additional measures need to be developed and tested.

Zanin, Stedefeldt, et al. (2021), assessed food handlers' practices over four months and incorporated participant observation data. This allowed for a more in-depth diagnosis of practices. Although resource-intensive, longitudinal food safety studies are scarce and should be encouraged.

Mixed-methods studies, (i.e., combining quantitative and qualitative research, are also promising). Quantitative methods such as microbial and chemical analysis and questionnaires and qualitative methods such as interviews, observations, participatory ethnographic study, focus group discussions, and video and document analysis on examining food safety will help to increase the reliability of data. Such combinations would help to ensure that the limitations of one single method are eliminated and would allow for a triangulation approach. The findings of a study are more valid when different data collection and analysis methods converge on the same conclusion (Carugi, 2016). Mixed methods designs would also offer the application of different research methods to study food safety behavior from more than one dimension using various data sources, as demonstrated by De Boeck et al. (2019), Palupi et al. (2020), and Mihalache et al. (2022). Additionally, longitudinal studies, such as those based on panel data and applying difference-in-differences analysis, should be strongly recommended to acknowledge the relationship between KAP components correctly.

Previous studies have demonstrated that knowledge is not always a strong predictor of self-reported or observed food safety practices. However, it plays an essential role and may be important for actual practices when mediated by attitudinal aspects, risk perceptions and beliefs. Even following the 'best practices' cited in this paper, researchers should first ask a critical question: "What novel findings, added values, or practical implications will this study bring?" Therefore, using the KAP model alone may be insufficient to measure food safety practices in different countries or contexts.

4. Concluding remarks

As mentioned, the KAP model has historically been used to address food handling and safety issues in food research. While the model provides an excellent foundation for incorporating key elements of knowledge and attitude into understanding food safety practices, it has not evolved with behavioral changes and new research findings. As experts and scientists strive for global food safety, the credibility of research must establish a critical foundation for food handling processes. This brief commentary is intended to help researchers identify key limitations of the KAP model and make recommendations for identified drawbacks. More than a diagnosis, researchers must pay attention to how their study can generate theoretical and practical implications. In this sense, research must be interdisciplinary and include food safety, statistics, risk analysis, psychology, pedagogy, and several other areas of knowledge.

Acknowledgments

DTC is thanks Cnpq – Conselho Nacional de Desenvolvimento Científico e Tecnológico for his productivity grant 310450/2021-7.

References

Abdul-Mutalib, N. A., Abdul-Rashid, M. F., Mustafa, S., Amin-Nordin, S., Hamat, R. A., & Osman, M. (2012). Knowledge, attitude and practices regarding food hygiene and sanitation of food handlers in Kuala Pilah, Malaysia. *Food Control, 27*(2), 289–293. https://doi.org/10.1016/j.foodcont.2012.04.001

Abdullah Sani, N., & Siow, O. N. (2014). Knowledge, attitudes and practices of food handlers on food safety in food service operations at the Universiti Kebangsaan Malaysia. *Food Control, 37*, 210–217. https://doi.org/10.1016/j.foodcont.2013.09.036

Ahmed, M. H., Akbar, A., & Sadiq, M. B. (2021). Cross sectional study on food safety knowledge, attitudes, and practices of food handlers in Lahore district, Pakistan. *Heliyon, 7*(11), Article e08420. https://doi.org/10.1016/j.heliyon.2021.e08420

Akabanda, F., Hlortsi, E. H., & Owusu-Kwarteng, J. (2017). Food safety knowledge, attitudes and practices of institutional food-handlers in Ghana. *BMC Public Health, 17*(1). https://doi.org/10.1186/s12889-016-3986-9

Al-Kandari, D., Al-abdeen, J., & Sidhu, J. (2019). Food safety knowledge, attitudes and practices of food handlers in restaurants in Kuwait. *Food Control, 103*, 103–110. https://doi.org/10.1016/j.foodcont.2019.03.040

Al-Shabib, N. A., Mosilhey, S. H., & Husain, F. M. (2016). Cross-sectional study on food safety knowledge, attitude and practices of male food handlers employed in restaurants of King Saud University, Saudi Arabia. *Food Control, 59*, 212–217. https://doi.org/10.1016/j.foodcont.2015.05.002

de Andrade, M. L., Stedefeldt, E., Zanin, L. M., & da Cunha, D. T. (2020). Food safety culture in food services with different degrees of risk for foodborne diseases in Brazil. *Food Control, 112*, Article 107152. https://doi.org/10.1016/J.FOODCONT.2020.107152

de Andrade, M. L., Stedefeldt, E., Zanin, L. M., Zanetta, L. D., & da Cunha, D. T. (2021). Unveiling the food safety climate's paths to adequate food handling in the hospitality industry in Brazil. *International Journal of Contemporary Hospitality Management, 33*(3), 873–892. https://doi.org/10.1108/IJCHM-09-2020-1030

Aquino, H. V. A., Yap, T., Lacap, J. P. G., Tuazon, G., & Flores, M. (2021). Food safety knowledge, attitudes, practices and training of fast-food restaurant food handlers: A moderation analysis. *British Food Journal, 123*(12), 3824–3840. https://doi.org/10.1108/BFJ-01-2021-0026

Baş, M., Şafak Ersun, A., & Kıvanç, G. (2006). The evaluation of food hygiene knowledge, attitudes, and practices of food handlers' in food businesses in Turkey. *Food Control, 17*(4), 317–322. https://doi.org/10.1016/j.foodcont.2004.11.006

Behnke, C., & Seo, S. (2015). Using smartphone technology to assess the food safety practices of farmers' market foodservice employees. *Journal of Foodservice Business Research, 18*(1), 1–19. https://doi.org/10.1080/15378020.2015.995748

Brannon, L. A., York, V. K., Roberts, K. R., Shanklin, C. W., & Howells, A. D. (2009). Appreciation of food safety practices based on level of experience. *Journal of Foodservice Business Research, 12*(2), 134–154. https://doi.org/10.1080/15378020902910462

Byrd-Bredbenner, C., Abbot, J. M., Wheatley, V., Schaffner, D., Bruhn, C., & Blalock, L. (2008). Risky eating behaviors of young adults—implications for food safety education. *Journal of the American Dietetic Association, 108*(3), 549–552. https://doi.org/10.1016/j.jada.2007.12.013

Carugi, C. (2016). Experiences with systematic triangulation at the global environment facility. *Evaluation and Program Planning, 55*, 55–66. https://doi.org/10.1016/j.evalprogplan.2015.12.001

Clayton, D. A., & Griffith, C. J. (2004). Observation of food safety practices in catering using notational analysis. *British Food Journal, 106*(3), 211–227. https://doi.org/10.1108/00070700410528790

Clayton, D. A., Griffith, C. J., Price, P., & Peters, A. C. (2002). Food handlers' beliefs and self-reported practices. *International Journal of Environmental Health Research, 12*(1), 25–39. https://doi.org/10.1080/09603120120110031

da Cunha, D. T., De Rosso, V. V., Pereira, M. B., & Stedefeldt, E. (2019). The differences between observed and self-reported food safety practices: A study with food handlers using structural equation modeling. *Food Research International, 125*, Article 108637. https://doi.org/10.1016/j.foodres.2019.108637

da Cunha, D. T., Stedefeldt, E., & de Rosso, V. V. (2014). The role of theoretical food safety training on Brazilian food handlers' knowledge, attitude and practice. *Food Control, 43*, 167–174. https://doi.org/10.1016/j.foodcont.2014.03.012

De Boeck, E., Jacxsens, L., Mortier, A. V., & Vlerick, P. (2018). Quantitative study of food safety climate in Belgian food processing companies in view of their organizational characteristics. *Food Control, 88*, 15–27. https://doi.org/10.1016/j.foodcont.2017.12.037

De Boeck, E., Jacxsens, L., Vanoverberghe, P., & Vlerick, P. (2019). Method triangulation to assess different aspects of food safety culture in food service operations. *Food Research International, 116*, 1103–1112. https://doi.org/10.1016/J.FOODRES.2018.09.053

Eagly, A. H., & Chaiken, S. (2007). The advantages of an inclusive definition of attitude. *Social Cognition, 25*(5), 582–602. https://doi.org/10.1521/soco.2007.25.5.582

Ehiri, J. E., Morris, G. P., & McEwen, J. (1997). Evaluation of a food hygiene training course in Scotland. *Food Control, 8*(3), 137–147. https://doi.org/10.1016/S0956-7135(97)00005-4

Elobeid, T., Savvaidis, I., & Ganji, V. (2019). Impact of food safety training on the knowledge, practice, and attitudes of food handlers working in fast-food restaurants. *British Food Journal, 121*(4), 937–949. https://doi.org/10.1108/BFJ-01-2019-0066

de Freitas, R. S. G., da Cunha, D. T., & Stedefeldt, E. (2019). Food safety knowledge as gateway to cognitive illusions of food handlers and the different degrees of risk perception. *Food Research International, 116*, 126–134. https://doi.org/10.1016/j.foodres.2018.12.058

Gruenfeldova, J., Domijan, K., & Walsh, C. (2019). A study of food safety knowledge, practice and training among food handlers in Ireland. *Food Control, 105*, 131–140. https://doi.org/10.1016/j.foodcont.2019.05.023

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2009). *Multivariate data analysis* (7th ed.). Pearson Education Limited.

Hansen, P. G., Larsen, E. G., & Gundersen, C. D. (2022). Reporting on one's behavior: A survey experiment on the nonvalidity of self-reported COVID-19 hygiene-relevant routine behaviors. *Behavioural Public Policy, 6*(1), 34–51. https://doi.org/10.1017/bpp.2021.13

Hashanuzzaman, M., Bhowmik, S., Rahman, M. S., Zakaria, M. U. M. A., Voumik, L. C., & Mamun, A.-A. (2020). Assessment of food safety knowledge, attitudes and practices of fish farmers and restaurants food handlers in Bangladesh. *Heliyon, 6*(11), Article e05485. https://doi.org/10.1016/j.heliyon.2020.e05485

Havelaar, A. H., Kirk, M. D., Torgerson, P. R., Gibb, H. J., Hald, T., Lake, R. J., Praet, N., Bellinger, D. C., de Silva, N. R., Gargouri, N., Speybroeck, N., Cawthorne, A., Mathers, C., Stein, C., Angulo, F. J., Devleesschauwer, B., & Group, on behalf of W. H. O. F. D. B. E. R.. (2015). World health organization global estimates and regional comparisons of the burden of foodborne disease in 2010. *PLoS Medicine, 12*(12), Article e1001923. https://doi.org/10.1371/journal.pmed.1001923

Ko, W. H. (2013). The relationship among food safety knowledge, attitudes and self-reported HACCP practices in restaurant employees. *Food Control, 29*(1), 192–197. https://doi.org/10.1016/j.foodcont.2012.05.076

Kwol, V. S., Eluwole, K. K., Avci, T., & Lasisi, T. T. (2020). Another look into the Knowledge Attitude Practice (KAP) model for food control: An investigation of the mediating role of food handlers' attitudes. *Food Control, 110*, Article 107025. https://doi.org/10.1016/j.foodcont.2019.107025

Letuka, P., Nkhebenyane, J., & Thekisoe, O. (2021). Street food handlers' food safety knowledge, attitudes and self-reported practices and consumers' perceptions about street food vending in Maseru, Lesotho. *British Food Journal, 123*(13), 302–316. https://doi.org/10.1108/BFJ-07-2020-0595

Luo, X., Xu, X., Chen, H., Bai, R., Zhang, Y., Hou, X., Zhang, F., Zhang, Y., Sharma, M., Zeng, H., & Zhao, Y. (2019). Food safety related knowledge, attitudes, and practices (KAP) among the students from nursing, education and medical college in Chongqing, China. *Food Control, 95*, 181–188. https://doi.org/10.1016/j.foodcont.2018.07.042

McCambridge, J., Witton, J., & Elbourne, D. R. (2014). Systematic review of the Hawthorne effect: New concepts are needed to study research participation effects. *Journal of Clinical Epidemiology, 67*(3), 267–277. https://doi.org/10.1016/j.jclinepi.2013.08.015

Mihalache, O. A., Møretrø, T., Borda, D., Dumitraşcu, L., Neagu, C., Nguyen-The, C., Maître, I., Didier, P., Teixeira, P., Lopes Junqueira, L. O., Truninger, M., Izsó, T., Kasza, G., Skuland, S. E., Langsrud, S., & Nicolau, A. I. (2022). Kitchen layouts and consumers' food hygiene practices: Ergonomics versus safety. *Food Control, 131*, Article 108433. https://doi.org/10.1016/J.FOODCONT.2021.108433

Milton, A. C., & Mullan, B. A. (2012). An application of the theory of planned behavior—a randomized controlled food safety pilot intervention for young adults. *Health Psychology, 31*(2), 250–259. https://doi.org/10.1037/a0025852. American Psychological Association.

Mohd Azaman, N. N., Kamarulzaman, N. H., Shamsudin, M. N., & Selamat, J. (2016). Stakeholders' knowledge, attitude, and practices (KAP) towards aflatoxins contamination in peanut-based products. *Food Control, 70*, 249–256. https://doi.org/10.1016/j.foodcont.2016.05.058

Mucinhato, R. M. D., da Cunha, D. T., Barros, S. C. F., Zanin, L. M., Auad, L. I., Weis, G. C. C., Saccol, A. L. de F., & Stedefeldt, E. (2022). Behavioral predictors of household food-safety practices during the COVID-19 pandemic: Extending the theory of planned behavior. *Food Control, 134*, Article 108719. https://doi.org/10.1016/j.foodcont.2021.108719

Mullan, B., Allom, V., Sainsbury, K., & Monds, L. A. (2015). Examining the predictive utility of an extended theory of planned behaviour model in the context of specific individual safe food-handling. *Appetite, 90*, 91–98. https://doi.org/10.1016/j.appet.2015.02.033

Mullan, B., & Wong, C. (2010). Using the Theory of Planned Behaviour to design a food hygiene intervention. *Food Control, 21*(11), 1524–1529. https://doi.org/10.1016/j.foodcont.2010.04.026

Ncube, F., Kanda, A., Chijokwe, M., Mabaya, G., & Nyamugure, T. (2020). Food safety knowledge, attitudes and practices of restaurant food handlers in a lower-middle-income country. *Food Sciences and Nutrition, 8*(3), 1677–1687. https://doi.org/10.1002/fsn3.1454

Neal, A., Griffin, M. A., & Hart, P. M. (2000). The impact of organizational climate on safety climate and individual behavior. *Safety Science, 34*(1), 99–109. https://doi.org/10.1016/S0925-7535(00)00008-4

Nyokabi, S., Luning, P. A., de Boer, I. J. M., Korir, L., Muunda, E., Bebe, B. O., Lindahl, J., Bett, B., & Oosting, S. J. (2021). Milk quality and hygiene: Knowledge, attitudes and practices of smallholder dairy farmers in central Kenya. *Food Control, 130*, Article 108303. https://doi.org/10.1016/j.foodcont.2021.108303

Oxford Dictionary. (2022). Definition of knowledge. In *Oxford advanced learner's dictionary*. Oxford University Press. https://www.oxfordlearnersdictionaries.com/definition/english/knowledge?q=knowledge.

Pacholewicz, E., Sura Barus, S. A., Swart, A., Havelaar, A. H., Lipman, L. J. A., & Luning, P. A. (2016). Influence of food handlers' compliance with procedures of poultry carcasses contamination: A case study concerning evisceration in broiler slaughterhouses. *Food Control, 68*, 367–378. https://doi.org/10.1016/j.foodcont.2016.04.009

Palupi, I. R., Fitasari, R. P., & Utami, F. A. (2020). Knowledge, attitude and practice of hygiene and sanitation among food-handlers in a psychiatric hospital in Indonesia - a mixed method study. *Journal of Preventive Medicine and Hygiene, 61*(4), E642–E649. https://doi.org/10.15167/2421-4248/jpmh2020.61.4.1526

Rebouças, L. T., Santiago, L. B., Martins, L. S., Rios Menezes, A. C., Araújo, M., da, P. N., & Almeida, R. C. de C. (2017). Food safety knowledge and practices of food handlers, head chefs and managers in hotels' restaurants of Salvador, Brazil. *Food Control, 73*, 372–381. https://doi.org/10.1016/j.foodcont.2016.08.026

van Rijen, D., Mergelsberg, E., Hoor, G. ten, & Mullan, B. (2021). Improving safe food-handling practices by increasing self-efficacy. *Food Control, 130*, Article 108361. https://doi.org/10.1016/j.foodcont.2021.108361

Scholderer, J., & Veflen, N. (2019). Social norms and risk communication. *Trends in Food Science & Technology, 84*, 62–63. https://doi.org/10.1016/j.tifs.2018.08.002

Siddiky, N. A., Khan, M. S. R., Sarker, M. S., Bhuiyan, M. K. J., Mahmud, A., Rahman, M. T., Ahmed, M. M., & Samad, M. A. (2022). Knowledge, attitude and practice of chicken vendors on food safety and foodborne pathogens at wet markets in Dhaka, Bangladesh. *Food Control, 131*, Article 108456. https://doi.org/10.1016/j.foodcont.2021.108456

Sirichokchatchawan, W., Taneepanichskul, N., & Prapasarakul, N. (2021). Predictors of knowledge, attitudes, and practices towards food safety among food handlers in Bangkok, Thailand. *Food Control, 126*, Article 108020. https://doi.org/10.1016/j.foodcont.2021.108020

Soon, J. M. (2019). Rapid Food Hygiene Inspection Tool (RFHiT) to assess hygiene conformance index (CI) of street food vendors. *Lebensmittel-Wissenschaft und -Technologie, 113*, Article 108304. https://doi.org/10.1016/j.lwt.2019.108304

Soon, J. M., & Baines, R. N. (2012). Food safety training and evaluation of handwashing intention among fresh produce farm workers. *Food Control, 23*(2), 437–448. https://doi.org/10.1016/j.foodcont.2011.08.012

Soon, Mei, J., Wahab, I. R. A., Hamdan, R. H., & Jamaludin, M. H. (2020). Structural equation modelling of food safety knowledge, attitude and practices among consumers in Malaysia. *PLoS One, 15*(7). https://doi.org/10.1371/journal.pone.0235870. e0235870–e0235870.

Sullivan, G. M., & Artino, A. R., Jr. (2013). Analyzing and interpreting data from likert-type scales. *Journal of Graduate Medical Education, 5*(4), 541–542. https://doi.org/10.4300/JGME-5-4-18

Taha, S., Osaili, T. M., Vij, M., Vij, A., Alhogaraty, E., Al-Utaibi, G., Albloush, A., Nassoura, A., Bohra, O. P., & Altaher, S. (2021). Measuring management practices impact on hygiene practices of food handlers: The mediating role of commitment and training perception. *Food Control, 130*, Article 108313. https://doi.org/10.1016/j.foodcont.2021.108313

Tan, S. L., Bakar, F. A., Abdul Karim, M. S., Lee, H. Y., & Mahyudin, N. A. (2013). Hand hygiene knowledge, attitudes and practices among food handlers at primary schools in Hulu Langat district, Selangor (Malaysia). *Food Control, 34*(2), 428–435. https://doi.org/10.1016/j.foodcont.2013.04.045

Vinodkumar, M. N., & Bhasi, M. (2010). Safety management practices and safety behaviour: Assessing the mediating role of safety knowledge and motivation. *Accident Analysis & Prevention, 42*(6), 2082–2093. https://doi.org/10.1016/j.aap.2010.06.021

Vo, T. H., Le, N. H., Le, A. T. N., Tran Minh, N. N., & Nuorti, J. P. (2015). Knowledge, attitudes, practices and training needs of food-handlers in large canteens in Southern Vietnam. *Food Control, 57*, 190–194. https://doi.org/10.1016/j.foodcont.2015.03.042

Wang, M., Huang, L., Pan, C., & Bai, L. (2021). Adopt proper food-handling intention: An application of the health belief model. *Food Control, 127*, Article 108169. https://doi.org/10.1016/J.FOODCONT.2021.108169

Webb, M., & Morancie, A. (2015). Food safety knowledge of foodservice workers at a university campus by education level, experience, and food safety training. *Food Control, 50*, 259–264. https://doi.org/10.1016/j.foodcont.2014.09.002

World Health Organization. (2019). *Estimating the burden of foodborne diseases*.

Wynder, E. L. (1994). Investigator bias and interviewer bias: The problem of reporting systematic error in epidemiology. *Journal of Clinical Epidemiology, 47*(8), 825–827. https://doi.org/10.1016/0895-4356(94)90184-8

Zanetta, L. D., Mucinhato, R. M., Hakim, M. P., Stedefeldt, E., & da Cunha, D. T. (2022). What motivates consumer food safety perceptions and beliefs? A scoping review in brics countries. *Foods, 11*(3), 432. https://doi.org/10.3390/foods11030432

Zanin, L. M., da Cunha, D. T., de Rosso, V. V., Capriles, V. D., & Stedefeldt, E. (2017). Knowledge, attitudes and practices of food handlers in food safety: An integrative review. *Food Research International, 100*(July), 53–62. https://doi.org/10.1016/j.foodres.2017.07.042

Zanin, L. M., Luning, P. A., da Cunha, D. T., & Stedefeldt, E. (2021). Influence of educational actions on transitioning of food safety culture in a food service context: Part 1 – triangulation and data interpretation of food safety culture elements. *Food Control, 119*, Article 107447. https://doi.org/10.1016/j.foodcont.2020.107447

Zanin, L. M., Stedefeldt, E., da Silva, S. M., da Cunha, D. T., & Luning, P. A. (2021). Influence of educational actions on transitioning of food safety culture in a food service context: Part 2 - effectiveness of educational actions in a longitudinal study. *Food Control, 120*, Article 107542. https://doi.org/10.1016/j.foodcont.2020.107542

Zhang, M., Zhu, Q., & Bai, J. (2022). The disparity between self-reported and observed food safety behavior: A case involving consumers from rural China. *Food Control, 138*, Article 108981. https://doi.org/10.1016/j.foodcont.2022.108981

Diogo Thimoteo da Cunha*
School of Applied Sciences, State University of Campinas (UNICAMP), Limeira, Brazil

Jan Mei Soon
Faculty of Allied-Health and Wellbeing, University of Central Lancashire, Preston, PR1 2HE, UK

Kayode Kolawole Eluwole
Department of Gastronomy and Culinary Arts, Faculty of Fine Arts, Istanbul Gelisim University, Turkey

Barbara A. Mullan
enAble Institute, Curtin University, Australia

Li Bai
School of Biological and Agricultural Engineering, Jilin University, China

Elke Stedefeldt
Department of Preventive Medicine, Universidade Federal de São Paulo (UNIFESP), São Paulo, Brazil

* Corresponding author. 1300 Pedro Zaccaria St, Jd Santa Luzia, Limeira, São Paulo, 13484-350, Brazil.
E-mail address: diogo.cunha@fca.unicamp.br (D.T. da Cunha).