

Determinants of behavior towards hemp-based products: an application of the theory of planned behavior

Hannah Lacasse, Jeffrey Buzas and Jane Kolodinsky
University of Vermont, Burlington, Vermont, USA

Tyler Mark

University of Kentucky, Lexington, Kentucky, USA

Rebecca Hill

Colorado State University, Fort Collins, Colorado, USA

William Snell

University of Kentucky, Lexington, Kentucky, USA, and

Heather Darby

University of Vermont, Burlington, Vermont, USA

Abstract

Purpose – This paper examines how U.S. consumer intentions to adopt hemp vary across product types using the theory of planned behavior (TPB).

Design/methodology/approach – Data were collected via an online survey of U.S. residents in 2022 (n = 1,948). Two-step structural equation modeling is used to examine how TPB constructs and background factors influence intent to use five different hemp-based products: cannabidiol (CBD), clothing, food, personal care products, and pet products. Data are analyzed using R.

Findings – Positive attitudes towards all categories of hemp-based products increase the probability of adoption, while subjective norm and perceived behavioral control have limited and varied significant influence across product models. Age has a consistent significant and negative influence on adoption.

Research limitations/implications – Findings highlight consumer segmentation and marketing opportunities, inform hemp stakeholder decision-making, and provide directions for future research. Given the absence of explanatory power of SN and PBC on most product models and the diversity of products and nuanced U.S. hemp policy, future research could investigate expanded iterations of TPB. Using revealed behavior could also highlight potential intention-behavior gaps and offer more robust insights for hemp stakeholders.

Originality/value – Findings contribute to a limited body of information on markets and consumer demand for hemp in the U.S.

Keywords Hemp, Theory of planned behavior, Consumer demand

Paper type Research paper

1. Introduction

The legalization of hemp in the United States offers a unique opportunity for farmers and entrepreneurs to explore hemp-based value-added products. Hemp's prospects as an

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agronomically sustainable crop and plant-based, renewable input (Ahmed *et al.*, 2022; Ely *et al.*, 2022b; Tripathi and Kumar, 2022) are amplified by its versatility as a food (Adesina *et al.*, 2020; Ciano *et al.*, 2022; Pihlanto *et al.*, 2017), textile and fiber (Bouloc and van der Werf, 2013; Montford and Small, 1999), medicine (Adesina *et al.*, 2020; Thompson *et al.*, 1998), polymer alternative (Ahmed *et al.*, 2022; Filimonova *et al.*, 2022), and biofuel (Das *et al.*, 2017). However, the sector faces several barriers, including a lack of information on market potential and consumer interest to guide producers navigating this nascent sector. Hemp's overall absence in production, and largely in U.S. markets, requires understanding how consumers perceive hemp products so that producers may synchronize production, manufacturing, and retailing with consumer needs. Understanding consumer behavior toward the breadth of hemp products is relevant as the industry considers relaxing restrictions and separating hemp floral regulation from that of fiber and grain (Johnson, 2023). The evolution of hemp regulation at the state and federal levels necessitates research on consumer perceptions to inform policy priorities and public education efforts to ensure the complex regulatory environment take into account the consumer experience. This article offers a foundational understanding of consumer behavior towards five different hemp product categories through an application of the theory of planned behavior, which provides an opportunity to compare how perceptions vary across product contexts. We extend the traditional model to include demographic characteristic to further compare how products do or do not require adapted segmentation opportunities, public education strategies, and research directions. Using a nationally representative U.S. sample, findings offer insight on strategy development across the supply chain and policy landscape.

Hemp was used throughout history for paper and textiles (Bouloc and van der Werf, 2013; Montford and Small, 1999); sailing canvas and rope (Meijer *et al.*, 1995; Robinson, 1996); medicine, therapy, and healing (Fike, 2016; Thompson *et al.*, 1998); and food (Adesina *et al.*, 2020; Pihlanto *et al.*, 2017). However, globalization and technological progress introduced unprecedented competition for hemp fiber and grain. The steam engine replaced sailboats, the cotton gin and enslavement made cotton the dominant material for clothing and textiles, and jute imports provided a more cost-effective rope alternative (Fortenbery and Bennett, 2004; Meijer *et al.*, 1995). In addition, a growing perception of hemp as a drug and its relationship to marijuana, coupled with racist and xenophobic tensions associated with its use, led to the Marijuana Tax Act of 1937 (Bewley-Taylor *et al.*, 2014; Gray, 2000). This prohibited U.S. hemp production and classified the crop as a Schedule I controlled substance (Fortenbery and Bennett, 2004).

It has since been established that hemp is distinctly different from marijuana, particularly in psychoactive tetrahydrocannabinol (THC) content (World Health Organization, 2018), though confusion regarding this distinction appears to present among the public (Goel *et al.*, 2023; Rampold *et al.*, 2021; Wysota *et al.*, 2022). In a regulatory sense, these recognized differences enable the pursuit of hemp for its agronomic prospects and ability to be processed into a breadth of renewable, and potentially sustainable, products. A desire for novel, value-added crops for farmers, rising consumer demand for plant-based alternatives (Jeske *et al.*, 2018), and motivations to substitute petroleum-dependent products for renewable, plant-based ones amid the rising realities of climate change (Ahmed *et al.*, 2022; Filimonova *et al.*, 2022) fostered this shift. There was also substantial excitement regarding prospects for cannabidiol (CBD), the major non-psychoactive cannabinoid naturally found in hemp plants and extracted from the female flower (Adesina *et al.*, 2020; World Health Organization, 2018). CBD is added to tinctures, supplements, edibles, and food products for therapeutic, medicinal, and recreational purposes (Rosenberg *et al.*, 2015; World Health Organization, 2018). It was through this combination of factors that the 2014 and 2018 Farm Bills legalized hemp production and removed hemp fiber and grain's designation as a controlled substance (Mark *et al.*, 2020).

Hemp's legalization prompted production increases in 2019, increasing by nearly 350% over 2018 when only federally approved pilot programs for research were allowed (Mark *et al.*, 2020). This attracted farmers and entrepreneurs from agricultural and non-agricultural backgrounds to grow hemp. The majority of production was and continues to be focused on floral biomass for CBD extraction, given the perceived profit estimates for the new and unknown market (Mark *et al.*, 2020). For some, these high price points were achieved, and contracts from buyers were solidified. This encouraged more CBD production. Soon, the reality of hemp's nascency hit aspiring producers. The cost efficiency of conventional alternatives continues to outcompete hemp textiles, oils, and composites (Cherney and Small, 2016). Processing constraints exacerbate the feasibility of hemp grain and fiber in terms of technological insufficiency, the number and scale of operational facilities (Mark and Snell, 2019; Sterns, 2019). Production focus on floral biomass for CBD with a largely unknown market and overinflated profit estimates resulted in an oversupply of CBD and a price collapse in 2019 and 2020. This was followed by a decline and stabilization of hemp acreage (Mark *et al.*, 2020; Quinton, 2021). The hemp sector continues to face regulatory change and uncertainty at the state and federal levels (Falkner *et al.*, 2023), which is motivated by producers with varied interests toward hemp floral, grain, and fiber, as well as marijuana. The first Farm Bill since hemp's legalization in 2018 generates discussion regarding potential modifications to hemp regulation, including reduced federal oversight, separate requirements for different end products, adapted THC testing requirements, and established quality, safety, and labeling requirements for foods and supplements containing CBD (Johnson, 2023).

Amid regulatory changes and production interest, hemp stakeholders are making decisions with limited research and data on the crop and its potential influence in US contexts. Several decades of prohibition meant research on seeds, plant breeding, agronomic practices, and processing technology was abandoned (Ely *et al.*, 2022b; Malone and Gomez, 2019), leaving stakeholders with highly outdated or geographically irrelevant information at the time of hemp's legalization. Research on consumer demand and market opportunities for hemp is specifically needed for the industry (Mark *et al.*, 2020), with markets, economics, and consumer perceptions identified as the second most important area of research to U.S. stakeholders (Ellison, 2021a). The current literature on consumer behavior towards hemp products in the U.S. is highly limited. Industry reports offer insight typically constrained to CBD and demographic characteristics (New Frontier Data, 2020). The remaining peer-reviewed literature conducted in the U.S. is either geographically constrained (Kolodinsky *et al.*, 2020; Kolodinsky and Lacasse, 2021; Lacasse *et al.*, 2023), focused on a specific product (Kogan *et al.*, 2016), or limited to evaluation of demographic characteristics (Kim and Mark, 2023).

There is an absence of refereed literature at the national level that examines consumer perceptions and values associated with the different types of products for which hemp can serve as a primary input. Without this consumer data, hemp stakeholders may continue to strategize and make decisions for an uncertain market. The unresolved and changing regulatory environment for hemp and its end uses further necessitates research on how consumers perceive and behave towards various hemp products. Therefore, this study explores perceptions, values, and attitudes associated with using five different types of hemp-based products (CBD, clothing, food, personal care products, and pet products) using the theory of planned behavior applied to a nationally representative survey of U.S. consumers.

2. Theoretical framework

The theory of planned behavior (TPB) examines human behavior within a specific context (Ajzen, 1991). Given that revealed behavior is typically challenging to observe, stated intent to execute the behavior is used as a proxy for the behavior itself (Ajzen, 2020). When

measured, behavior is a function of intention. Intention is a function of three constructs that are core to the theory: attitude, subjective norm, and perceived behavioral control. Attitude reflects an individual's belief that performing the behavior will result in a specific outcome or experience. Aggregating these beliefs generates an overall attitude toward the behavior, either positive or negative. A subjective norm is a construct containing normative beliefs that measure social pressure to participate in a behavior. Perceived behavioral control reflects a person's perception of their actual control over their ability to execute the behavior and the ease or difficulty associated with performing it. These typically relate to measures of access or skill, such as time or financial resources, and can either facilitate or obstruct the behavior. It is assumed that perceived behavioral control moderates the influence of attitude and subjective norm on intention. All factors are assumed to influence a behavior positively.

The theory of planned behavior has been applied extensively to food choice (Ahmed *et al.*, 2022; Ajzen, 2016; Khan *et al.*, 2022; Kuran and Mihic, 2014; Scalco *et al.*, 2017), pro-environmental behaviors (Biasini *et al.*, 2023; Gansser and Reich, 2023; Lavuri, 2022; Srivastava *et al.*, 2023; Teixeira *et al.*, 2022; Yuriev *et al.*, 2020), health behaviors (Cho *et al.*, 2023; Lareyre *et al.*, 2021; Limbu *et al.*, 2022; Riebl *et al.*, 2015; Shanka and Gebremariam Kotecho, 2023), and hospitality (Chen *et al.*, 2023; Fauzi *et al.*, 2022; Ulker-Demirel and Ciftci, 2020). It has also been applied to behaviors related to marijuana with medicinal or recreational purposes (Earle *et al.*, 2020; Fiegel and Frank, 2023; Pepper *et al.*, 2020; Tripathi and Kumar, 2022), though we only identify a single study at time of publication that use TPB in the context of hemp-based products without tetrahydrocannabinol (THC), the compound that produces psychoactive effects (World Health Organization, 2018). Metcalf *et al.* (2021a, b) examine the adoption of newly legalized hemp food among Australian consumers and find that subjective norm is the greatest indicator of hemp food consumption. However, the unique historical context of the United States justifies the exploration of TPB domestically. In addition, food is just one of the many end-uses of hemp. Exploring the many types of hemp-based products available is critical for policy, production, and marketing decisions for this nascent industry, particularly given that regulation and production considerations vary by end-use (Ellison, 2021a; Ely *et al.*, 2022a; Johnson, 2023; Mark *et al.*, 2020). This study, therefore, examines the extent to which intent to use hemp-based products is influenced by TPB constructs among U.S. consumers. We apply the theory to five categories of hemp-based products (CBD, food, clothing, personal care products, and pet products) to gain product-specific understanding and compare consumer perception and intent. The following section describes our hypothesis development. We retain the same hypothesis for each product model examined, which is generalized to "hemp products" for abbreviation.

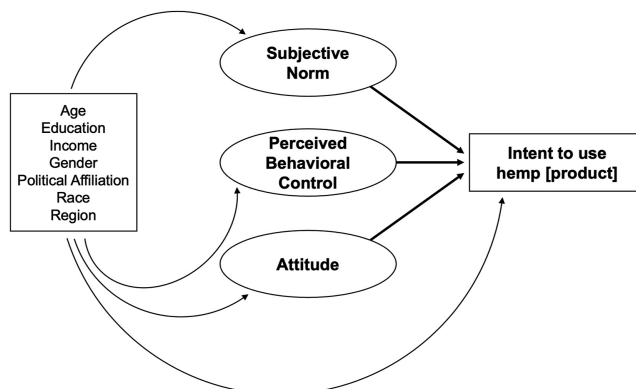
Attitude (ATT) measures an individual's perception that a behavior will be positive or negative. The conceptual models for this study measure attitude using questions for each product category relating to the respondent's positive evaluation of the given product. We hypothesize that more positive perceptions of hemp-based products will positively influence their intended use. Social pressure and influence on a particular behavior are measured with subjective norms (SN). Given hemp's historic and current associations with marijuana and drugs and confusion surrounding hemp's THC content, social pressure to avoid hemp-based products may be particularly salient under certain conditions. This study measures subjective norms using consumer evaluation of supportive networks in relation to each hemp product category. As social acceptance towards hemp product use increases, we hypothesize that intended use will be positively influenced. Perceived behavior control (PBC) measures an individual's perception of the ease or difficulty in executing a behavior, which we measure using affordability and availability. We hypothesize that fewer perceived constraints and greater perceived behavioral control will positively influence intent to adopt hemp products.

The standard TPB framework is limited in its ability to account for other environmental and economic factors that characterize choice. As such, expanded iterations of the model have

been applied to improve understanding of behavior (Rozenkowska, 2023), such as the examination of trust (Cao *et al.*, 2023), goal motivations (Ajzen and Kruglanski, 2019; Hamilton *et al.*, 2024), environmental consciousness (Gansser and Reich, 2023; Müller *et al.*, 2021), and previous behavior (Biasini *et al.*, 2023). Given that hemp products are relatively new to US markets and consumer research is limited, we examine the standard TPB model to provide an initial understanding of consumer behavior towards various hemp products. Consumer choice motives will likely vary across the many types of hemp products in the market. However, starting with a basic TPB model provides a starting point for comparing hemp products, inform opportunities for shared approaches, and highlight areas where research should be unique to specific products. The TPB framework also considers socio-demographic background factors, which do not directly relate to the behavior of interest but inform beliefs and are mediated by the role of TPB constructs on intention and behavior (Ajzen, 2020; Rise *et al.*, 2010). To provide a more robust foundational understanding of consumer behavior towards hemp and offer greater insight into segmentation and public education opportunities, we examine the role of socio-demographic characteristics in our TPB models. Specifically, we examine the influence of age, education, income, gender, political affiliation, race, and region indirectly via the TPB constructs and directly on intention (Figure 1). Demographic influence in the existing literature on hemp product consumption is varied. Older consumers are less likely to purchase hemp products compared to younger consumers (Kim and Mark, 2023; Lacasse *et al.*, 2023). Higher incomes and higher levels of education are also associated with hemp use (Kim and Mark, 2023). Studies specific to CBD use find similar demographic associations related to age, income, and education (Choi and Hwang, 2023; Goodman *et al.*, 2022; Staples *et al.*, 2022). Though hemp was legalized nationally, production requirements and policies vary at the state-level (Falkner *et al.*, 2023) and may impact the consumer space (Kim and Mark, 2023). We include a region variable to account for geographic influence of hemp adoption. A comparison of hemp product categories using TPB with demographic background factors has yet to be examined and may shed light on whether, despite being hemp-based, different products require specific market segmentation and policy strategies.

3. Methods

This study uses a nationally representative online survey of U.S. consumers collected via Qualtrics in 2022. Responses were screened for completeness and completion time (n = 1948).



Source(s): Authors work

Figure 1. Conceptual model for intent to adopt hemp-based products based on the theory of planned behavior (Ajzen, 1991)

The survey asks about awareness, use, and perceptions of hemp-based products based on industry market estimates (Grand View Research, 2020) to reflect current product offerings: CBD, food, clothing, personal care products, and pet products. We model TPB for each of the five product categories, each of which are composed of a sample of product-aware consumers. Latent variable measurements for attitude, subjective norm, and perceived behavioral control are based on previous peer-reviewed literature (Ajzen, 2020; Rogers *et al.*, 1983) and measured as 5-point Likert scales, where 1 = strongly disagree and 5 = strongly agree (Table 1). TPB uses intent to adopt a behavior as a precursor to the behavior itself (Ajzen, 1991). This study uses intent to adopt the given hemp-based product as a proxy for adoption – a limitation but frequent practice given that actual behavior is difficult to measure. Intention is measured as a binary variable, where 1 indicates intent to use the hemp product in the future, and 0 otherwise. Though this presents a partial violation of the principle of compatibility, specifically scale compatibility (where intent and TPB constructs are measured at the same scale), we retain behavior compatibility in that the constructs refer to the target, action, and context of interest (Ajzen, 2020). We examine the influence of background factors on all latent variables and product adoption; all are measured as dummy variables (Table 2).

This study uses two-step structural equation modeling. First, confirmatory factor analysis (CFA) is applied to determine the reliability and validity of the latent TPB constructs (Knoke, 2004; Mueller and Hancock, 2001). Because the theory asserts that TPB constructs are correlated (Ajzen, 1991), we apply a correlated multi-factor CFA. The variance standardization method is applied to the CFA, where the variance of each factor is fixed to 1 but freely estimates all loadings (Rosseel, 2012). Model fit is based on chi-square, comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA). Though good model fit should result in failing to reject the χ^2 model, larger sample sizes typically result in rejecting the null, hence relying on the other measures of fit to fully assess model adequacy (Mueller and Hancock, 2001). A model is deemed a good fit if the CFI and TLI values are greater than 0.90, and the RMSEA value is less than 0.20 (Hair *et al.*, 2006). Factor loadings, Cronbach's alpha, and composite reliability are tested to evaluate internal consistency, validity, and reliability of the TPB constructs, respectively (Bagozzi and Yi, 2012; Shrestha, 2021). Any indicators with factor loadings less than 0.50 were removed from the model and determined to be a poor fit for the latent measurement (Cheung *et al.*, 2023). A Cronbach's alpha value greater than 0.7 and composite reliability value greater than 0.6 are considered acceptable (Shrestha, 2021). Average variance extracted (AVE) is measured to confirm the convergent validity of constructs; a value of 0.5 or higher confirms convergent validity. The discriminant validity of the constructs is tested by comparing the AVE for each construct with the squared inter-construct correlation. Discriminant validity is confirmed when the AVE is greater than the squared inter-construct correlation, though this measure is critiqued for relying on rules of thumb as opposed to statistical procedures (Cheung *et al.*, 2023). As such, we also evaluate the heterotrait-monotrait (HTMT) ratio of correlations; a value lower than 0.9 is desired (Henseler *et al.*, 2015). We then use structural equation modeling to test the relationships in the conceptual models (Figure 1). The TPB constructs (ATT, SN, and PBC) and all background factors are regressed onto intention. We also mediate the effect of background factors on intention by regressing them onto each TPB construct. The indirect and total effects of background factors on product intention are computed. Because our dependent variable (intent to adopt) is binary, probit regression is used to estimate model parameters fit via diagonally weighted least squares (Rosseel, 2012). This results in a probit regression with a weighted least squares estimator (Rosseel, 2012; UCLA: Statistical Consulting Group, n.d.). These steps are conducted simultaneously using the lavaan package in R (Anderson and Gerbing, 1988; Rosseel, 2012).

Table 1.
Variable definitions
and mean values for
survey questions by
TPB construct across
hemp product
categories

Measurement definition by TPB construct ¹	CBD		Clothing		Food		Personal care		Pet products	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
ATT1 Using hemp [product] is good	3.46	1.10	3.72	0.90	3.53	1.00	3.76	0.90	3.63	1.03
ATT2 Using hemp [product] is beneficial	3.47	1.10	3.60	0.89	3.58	1.02	3.65	0.96	3.62	0.98
ATT3 Which of the following best describes your attitude towards hemp [product]?	3.61	1.03	3.82	0.86	3.68	0.98	3.86	0.91	3.78	0.98
ATT4 Using hemp [product] is unnecessary	3.10	1.19	2.93	1.05	3.07	1.15	2.95	1.13	3.06	1.16
SN1 The people important to me approve of me using hemp [product]	3.25	1.11	3.30	0.92	3.30	1.04	3.48	1.00	3.31	1.01
SN2 The people important to me want me to use hemp [product]	2.94	1.14	2.98	1.04	3.06	1.10	3.35	1.04	3.14	1.09
SN3 I would use hemp [product] if I saw others using it too	3.01	1.17	3.25	1.01	3.24	1.15	3.28	1.10	3.37	1.10
PBC1 Using hemp [product] is possible for me	3.58	1.06	3.49	0.96	3.55	1.06	3.77	0.89	3.57	1.02
PBC2 Substituting conventional product alternatives for hemp-based [product] is easy	3.32	1.03	3.31	0.96	3.27	1.06	3.50	0.94	3.41	1.00
PBC3 I can afford hemp [product]	3.48	1.02	3.44	0.92	3.52	0.99	3.68	0.93	3.63	0.99
PBC4 Hemp [product] is available for me to try before I decide whether to use it	3.30	1.06	3.04	1.03	3.22	1.08	3.30	1.04	3.24	1.10
PBC5 Using hemp [product] is practical for me	3.31	1.16	3.28	0.99	3.31	1.10	3.55	0.98	3.42	1.09
PBC6 Hemp [product] is difficult to find	2.77	1.05	3.45	0.99	3.26	1.06	3.06	1.11	3.09	1.08
Observations ²	944		604		602		682		384	

Note(s): ¹ATT, SN, and PBC variables are measured on a 5-point Likert scale, where 1 = strongly disagree, 3 = neutral, and 5 = strongly agree
²Samples for each product category include respondents who are aware of the given product, hence observations vary across product categories
Source(s): Authors' work

Background factors	CBD	Clothing	Food	Personal care Percent	Pet products
Age					
Younger than 54 *	66.6	68.2	78.2	75.8	78.7
55 or older	33.4	31.8	21.8	24.2	21.4
Education					
Less than a college degree *	57.6	51.3	57.3	58.1	57.3
College degree or more	42.4	48.7	42.7	41.9	42.7
Income					
Less than \$55,000/year *	54.1	48.8	52.0	50.4	53.1
\$55,000/year or higher	45.9	51.2	48.0	49.6	46.9
Gender					
Male *	55.4	57.0	52.2	47.5	50.8
Female	44.6	43.1	47.8	52.5	49.2
Political affiliation					
Republican *	26.6	26.5	23.1	25.5	26.3
Democrat	40.4	40.1	41.7	41.6	38.8
Independent	28.6	27.5	30.9	29.3	28.4
Other political affiliation	4.5	6.0	4.3	3.5	6.5
Race					
White *	74.9	79.5	73.8	75.5	81.0
BIPOC	25.1	20.5	26.3	24.5	19.0
Region					
West *	19.2	23.7	19.1	20.7	21.9
South	41.5	35.9	42.0	39.0	35.4
Northeast	17.9	18.5	18.3	18.2	18.0
Midwest	21.4	21.9	20.6	22.1	24.7
Observations ¹	944	604	602	682	384

Note(s): * Asterisk indicates reference category

¹Samples for each product category include respondents who are aware of the given product, hence observations vary across product categories

Source(s): Authors' work

Table 2.
Frequencies for background factors by hemp product category

4. Results

4.1 Measurement model

CFA determines the reliability of the measurement models. All CFI and TLI values are greater than 0.9 (Table 3), demonstrating good model fit. The RMSEA values meet reasonable approximate fit criteria (0.05–0.08). Two questions were removed due to low factor loadings (ATT4: “Using hemp [product] is unnecessary” and PBC6: “Hemp [product] is difficult to find”). After removing both variables, standardized factor loadings for each variable and model exceed 0.5, with three measures (5%) less than 0.6 and 36 measures (65%) greater than 0.7. All Cronbach’s alpha values exceed 0.7 and all composite reliability scores exceed 0.6. The majority of AVE values are higher than 0.5, but three values for PBC are higher than 0.4 (0.44–0.49). Since the composite reliability scores are within an acceptable range, the AVE scores of this study are considered adequate (Shrestha, 2021). Though discriminant validity is not confirmed by the comparison of AVE and squared inter-construct correlation, we do confirm discriminant validity with the HTMT values, all of which meet the 0.9 threshold.

4.2 Structural model analysis

Model results (Table 4) reveal that increases in ATT significantly increase the probability of adoption across all hemp product models. SN positively influences the adoption of hemp personal care products, but negatively influences the adoption of hemp pet products.

Measure			CBD	Clothing	Food	Personal care	Pet products	
Factor loadings ¹	ATT1	Using hemp [product] is good ¹	0.90	0.82	0.87	0.85	0.89	
	ATT2	Using hemp [product] is beneficial	0.89	0.81	0.88	0.81	0.83	
	ATT3	Which of the following best describes your attitude towards hemp [product]?	0.78	0.65	0.69	0.69	0.75	
	SN1	The people important to me approve of me using hemp [product]	0.82	0.81	0.83	0.80	0.80	
	SN2	The people important to me want me to use hemp [product]	0.76	0.80	0.84	0.74	0.76	
	SN3	I would use hemp [product] if I saw others using it too	0.74	0.64	0.73	0.66	0.69	
	PBC1	Using hemp [product] is possible for me	0.79	0.72	0.81	0.75	0.80	
	PBC2	Substituting conventional product alternatives for hemp-based [product] is easy	0.61	0.60	0.73	0.68	0.75	
	PBC3	I can afford hemp [product]	0.53	0.60	0.65	0.60	0.64	
	PBC4	Hemp [product] is available for me to try before I decide whether to use it	0.60	0.57	0.67	0.57	0.65	
	PBC5	Using hemp [product] is practical for me	0.87	0.82	0.85	0.82	0.85	
	Comparative fit index (CFI)			0.97	0.95	0.98	0.97	0.95
	Tucker-Lewis index (TLI)			0.96	0.94	0.97	0.96	0.94
	Room mean square error of approximation (RMSEA)			0.07	0.08	0.06	0.06	0.08
	90% CI (upper)			0.08	0.09	0.07	0.07	0.09
90% CI (lower)			0.06	0.07	0.05	0.05	0.07	
Composite reliability								
ATT			0.89	0.81	0.86	0.83	0.86	
SN			0.82	0.80	0.84	0.78	0.79	
PBC			0.80	0.79	0.85	0.80	0.85	
Average variance extracted (AVE)								
ATT			0.74	0.59	0.68	0.62	0.69	
SN			0.60	0.57	0.64	0.54	0.57	
PBC			0.49	0.44	0.56	0.47	0.55	
Cronbach's alpha								
ATT			0.89	0.80	0.86	0.83	0.87	
SN			0.82	0.78	0.84	0.77	0.80	
PBC			0.83	0.80	0.86	0.82	0.86	
Squared inter-construct correlation								
ATT-SN			0.74	0.64	0.68	0.67	0.65	
ATT-PBC			0.87	0.68	0.80	0.82	0.64	
SN-PBC			0.84	0.67	0.79	0.80	0.68	
Heterotrait-Monotrait (HTMT) ratio of correlations								
ATT-SN			0.87	0.83	0.85	0.82	0.80	
ATT-PBC			0.87	0.80	0.86	0.85	0.77	
SN-PBC			0.88	0.79	0.89	0.89	0.81	

Table 3. Factor loadings, fit statistics, reliability, and validity measures for TPB constructs across each hemp product model

Note(s): ¹ Factor loadings are standardized
Source(s): Authors' work

Dependent variable	CBD		Clothing		Food		Personal care		Pet products	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
ATT	0.70***	0.09	0.52***	0.08	0.73***	0.09	0.55***	0.09	0.53***	0.10
SN	-0.05	0.10	-0.10	0.11	0.09	0.12	0.25*	0.13	-0.24*	0.11
PBC	0.15	0.11	0.34***	0.10	0.01	0.12	0.01	0.15	0.54***	0.09
Age	-0.46***	0.09	-0.61***	0.14	-0.35***	0.12	-0.16	0.10	-0.67***	0.18
Education	-0.04	0.08	0.10	0.10	-0.07	0.10	-0.22**	0.09	-0.04	0.13
Income	0.05	0.08	-0.05	0.10	0.16*	0.10	0.15*	0.09	-0.06**	0.13
Female	-0.07	0.08	0.17*	0.10	0.07	0.09	0.19**	0.08	0.07	0.12
Democrat	-0.27***	0.09	-0.33***	0.12	-0.12	0.11	-0.19*	0.11	-0.32*	0.15
Independent	-0.13	0.10	-0.29**	0.13	-0.26**	0.12	-0.26**	0.11	-0.30*	0.15
Other political aff	-0.40**	0.18	-0.07	0.18	-0.22	0.25	-0.33	0.27	-0.49*	0.21
BIPOC	0.13	0.09	0.16	0.12	0.18*	0.10	0.06	0.11	0.02	0.14
South	-0.01	0.10	-0.05	0.13	-0.11	0.13	0.01	0.12	-0.17	0.16
Northeast	0.03	0.12	0.07	0.15	-0.01	0.14	0.09	0.13	-0.36*	0.18
Midwest	-0.19	0.12	0.11	0.14	-0.37**	0.15	-0.02	0.13	-0.25	0.18

Covariance	CBD		Clothing		Food		Personal care		Pet products	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
ATT ~ SN	0.85***	0.01	0.80***	0.02	0.83***	0.02	0.81***	0.02	0.78***	0.02
ATT ~ PBC	0.89***	0.01	0.78***	0.02	0.86***	0.01	0.87***	0.01	0.76***	0.02
SN ~ PBC	0.89***	0.01	0.81***	0.02	0.89***	0.01	0.89***	0.02	0.80***	0.03

Note(s): * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Source(s): Authors' work

Table 4. Covariance measures and SEM regression results for direct effects of TPB constructs and background factors on intent to adopt each hemp product

Increases in PBC increases the probability of purchasing hemp clothing and personal care products. Older consumers decrease the probability of adopting CBD, clothing, food, and pet products compared to younger consumers. Across the majority of product models, identifying politically as Democrat or Independent decreases the likelihood of adoption compared to Republican respondents. The remaining background factors have inconsistent associations across product models. For example, higher incomes are associated with increased probabilities of adopting hemp food and personal care products. Being female increases the probability of hemp clothing and personal care product adoption.

4.3 Moderating effects

Within the structural TPB model, we mediate the role of background factors through the TPB constructs. Age negatively influences perceptions of all constructs across all products (Table 5). Older consumers are less likely to have a positive ATT, perceive positive SN, and have strong PBC towards hemp products compared to younger consumers. Being female also negatively influences SN and PBC perceptions of most hemp product categories. Female respondents are less likely to have positively perceived SN toward hemp CBD, clothing, food, and personal care products, and are less likely to have high PBC towards clothing, food, and personal care products. The remaining significant influence of background factors varies across product categories for each TPB construct. However, we find more consistency of background factor influence across constructs of a given hemp product. Democrats are more likely to have more positive ATT, SN, and PBC towards CBD compared to Republicans. Higher income respondents are more likely to have more positive ATT, SN, and PBC towards hemp pet products compared to lower income respondents.

4.4 Indirect and total effects

We calculate the indirect effects of background factors on product intention as mediated by the TPB constructs. Age has significant and negative indirect and total effects on intent to use all product categories (Table 6). Compared to Republicans, Independent respondents have a significant and negative total effect on intent to use hemp clothing, food, personal care products, and pet products. The remaining background factors have inconsistent and varying effects on intention. Democrats have a significant and positive indirect effect on hemp CBD and personal care products. Higher incomes have a significant and positive indirect effect on intent use hemp food and personal care products. BIPOC respondents have a negative indirect effect on intent to use hemp CBD. Being in the Midwest has a negative total effect on intent to use hemp CBD and hemp food, compared to respondents located in the West.

5. Discussion and conclusion

As the hemp industry settles from its first few turbulent years of legalization and the regulatory landscape continues to evolve, the economic viability of hemp in the U.S. remains in need of information related to hemp markets and consumer demand. The policy environment for hemp is in transition, with potential separation of hemp floral regulation from that of fiber and grain (Johnson, 2023). Though CBD continues to be the focus among producers, production has stabilized since the first years of legalization and the industry faces a new wave of interest across all types of hemp products, such as food and personal care (Grand View Research, 2020). Given that stakeholders have already expressed a desire for research on consumer demand and perceptions of hemp-based products (Ellison, 2021b), the potential policy changes facing the industry further compound the need to determine how and to what extent consumers of CBD, fiber, and grain products vary. Such an examination

Mediator and Background factor	CBD	Clothing	Food	Personal care	Pet products			
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient			
	SE	SE	SE	SE	SE			
ATT	Age	-0.68***	0.11	-0.61***	0.12	-0.70***	0.14	
	Education	-0.08	0.10	-0.05	0.10	-0.04	0.08	
	Income	0.00	0.10	0.20**	0.10	-0.02	0.08	
	Female	0.01	0.09	-0.13	0.09	-0.04	0.07	
	Democrat	0.20**	0.12	-0.01	0.12	0.14	0.09	
	Independent	-0.03	0.13	-0.16	0.13	-0.10	0.09	
	Other political aff	0.14	0.21	0.10	0.27	0.45*	0.18	
	BIPOC	-0.18**	0.08	-0.15	0.10	0.02	0.08	
	South	-0.06	0.13	0.13	0.13	-0.09	0.10	
	Northeast	-0.05	0.11	0.03	0.15	-0.13	0.12	
	Midwest	-0.10	0.14	0.00	0.14	-0.27**	0.11	
	SN	Age	-0.76***	0.11	-0.78***	0.12	-0.67***	0.08
		Education	-0.13	0.10	0.06	0.11	0.01	0.08
		Income	-0.03	0.08	0.11	0.10	0.00	0.08
Female		0.17**	0.07	-0.39***	0.09	-0.25***	0.07	
Democrat		0.16*	0.09	-0.02	0.13	0.30***	0.09	
Independent		0.02	0.10	-0.21	0.14	-0.06	0.10	
Other political aff		-0.01	0.18	-0.26	0.26	0.20	0.18	
BIPOC		-0.18**	0.09	-0.20*	0.10	-0.20**	0.09	
South		-0.14	0.10	0.23*	0.13	-0.12	0.10	
Northeast		-0.02	0.12	0.17	0.15	-0.17	0.12	
Midwest		-0.16	0.12	-0.02	0.15	-0.28*	0.12	
PBC		Age	-0.58***	0.10	-0.66***	0.11	-0.51***	0.08
		Education	-0.11	0.08	0.04	0.10	0.12	0.08
		Income	0.11	0.08	0.21**	0.10	0.06	0.08
	Female	-0.11	0.07	-0.21**	0.09	-0.17*	0.07	
	Democrat	0.15*	0.09	-0.02	0.12	0.22**	0.09	
	Independent	-0.05	0.10	-0.17	0.13	-0.01	0.10	
	Other political aff	-0.19	0.17	-0.35	0.25	0.06	0.17	
	BIPOC	-0.10	0.09	-0.04	0.10	0.11	0.09	
	South	-0.05	0.10	0.04	0.13	-0.10	0.10	
	Northeast	-0.01	0.12	0.15	0.15	-0.14	0.12	
	Midwest	-0.12	0.11	-0.07	0.14	-0.20	0.11	

Note(s): * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source(s): Authors' work

Table 5. SEM regression results for the influence of background factors on TPB constructs across each hemp product

Table 6.
Indirect and total
effects of background
factors on intent to use
hemp products

Background factor ¹	CBD		Clothing		Food		Personal care		Pet products		
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	
Age	Indirect	-0.52***	0.06	-0.35***	0.08	-0.52***	0.10	-0.50***	0.08	-0.49***	0.13
	Total	-0.98***	0.10	-0.95***	0.14	-0.87***	0.15	-0.66***	0.12	-1.16***	0.19
Education	Indirect	-0.06	0.06	0.05	0.07	-0.03	0.08	-0.02	0.08	-0.04	0.10
	Total	-0.10	0.09	0.15	0.12	-0.11	0.12	-0.24**	0.11	-0.08	0.16
Income	Indirect	0.02	0.06	0.06	0.07	0.16**	0.08	-0.01	0.07	0.23**	0.10
	Total	0.07	0.09	0.01	0.12	0.32***	0.12	0.14	0.11	0.17	0.15
Female	Indirect	0.00	0.06	-0.14**	0.07	-0.13	0.08	-0.08	0.07	0.02	0.09
	Total	-0.07	0.09	0.03	0.12	-0.06	0.11	0.11	0.10	0.09	0.14
Democrat	Indirect	0.15**	0.07	0.11	0.09	-0.01	0.10	0.16*	0.08	0.16	0.12
	Total	-0.11	0.11	-0.21	0.15	-0.13	0.14	-0.04	0.13	-0.16	0.18
Independent	Indirect	-0.03	0.07	-0.03	0.09	-0.14	0.10	-0.07	0.09	-0.01	0.13
	Total	-0.16	0.12	-0.32**	0.15	-0.39**	0.15	-0.33**	0.14	-0.31*	0.19
Other political aff.	Indirect	0.07	0.14	0.11	0.16	0.05	0.22	0.30	0.20	0.16	0.20
	Total	-0.32	0.22	0.04	0.24	-0.17	0.28	-0.03	0.27	-0.33	0.28
BIPOC	Indirect	-0.13**	0.07	0.03	0.09	-0.13	0.08	-0.04	0.09	-0.01	0.12
	Total	0.00	0.11	0.19	0.14	0.06	0.13	0.02	0.12	0.01	0.18
South	Indirect	-0.04	0.08	0.01	0.09	0.11	0.10	-0.08	0.09	0.09	0.13
	Total	-0.05	0.12	-0.04	0.15	0.00	0.15	-0.07	0.14	-0.07	0.18
Northeast	Indirect	-0.03	0.09	0.02	0.11	0.04	0.12	-0.11	0.11	0.07	0.15
	Total	0.00	0.14	0.09	0.18	0.03	0.17	-0.03	0.16	-0.28	0.21
Midwest	Indirect	-0.08	0.09	-0.08	0.10	0.00	0.12	-0.22**	0.10	0.07	0.14
	Total	-0.27*	0.14	0.04	0.17	-0.37**	0.17	-0.23	0.16	-0.18	0.20

Note(s): ¹The direct effect of background factors can be found in [Table 4](#)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source(s): Authors' work

could inform upcoming policy changes, offer opportunities for public education, and enable strategic production decisions. Here, we offer a foundational understanding of how perceptions and use of hemp varies across different product categories and shed light on policy, production, and research implications.

Results reveal that attitude is positively associated with use intention for all categories of hemp-based products. The consistency across product models offers an opportunity for attitude-motivating approaches that can be applied to any hemp product. Findings from [Dolgopolova et al. \(2021\)](#) suggest that framing hemp's positive attributes could improve attitude and subsequently use intention. Though their study is applied to food products specifically, it points to opportunities to better understand and highlight salient attributes for hemp consumers in production and marketing efforts. The extent to which hemp regulations impact consumer attitudes also appears to be an important consideration amid impending policy changes at the federal and state levels.

Attitude is the only significant TPB construct that consistently influences all product categories. The remaining constructs have varied influence. Hemp clothing and pet products are positively influenced by PBC, highlighting accessibility and price points as relevant considerations for hemp producers and retailers. Adoption of hemp personal care products is positively influenced by subjective norm, or when respondents feel that using hemp personal care products is socially acceptable. This could indicate concern for the opinion of others and may reflect a lingering stigma associated with hemp consumption ([Metcalfe et al., 2021a, b](#)). This study does not explicitly include marijuana or THC perceptions, but exploring marijuana perceptions as a mediating effect of TPB may help shed light on the role of social pressure in hemp consumption. Pet products exhibit the opposite pattern: the less socially acceptable respondents perceive hemp pet products to be, the more likely they are to use them. This disregard for perceptions of family or friends could be due to other, stronger beneficial attributes that are not factored into our model, such as potential or perceived health effects ([Corsato Alvarenga et al., 2023](#); [Kogan et al., 2016](#); [Coelho et al., 2021](#)), which may be worthy of future research.

An analysis of consumer adoption of hemp food in Australia found that attitude did not influence adoption and subjective norm was the most influential construct ([Metcalfe et al., 2021a, b](#)). Comparatively, our study finds that attitude alone significantly and positively influences hemp food. The variation in findings may be due to Australia's overt illegality of hemp seed as food. Hemp seed in the U.S. was only prohibited in production and remained, albeit in low amounts, on the market before 2018 legalization. Different policies result in different outcomes, even if they are related to hemp, and this comparison of findings highlights the necessity to evaluate hemp markets within a U.S.-specific context.

Incorporating socio-demographic characteristics offers insight on how efforts to increase hemp use, inform policy, and improve TPB construct perceptions can be segmented. Age is the most consistently influential background factor across product models. Regardless of product type, older people are almost always significantly associated with lower measurements of ATT, SN, and PBC, and are less likely to have use intention than younger respondents. This reinforces trends found in the existing literature on hemp and CBD adoption ([Choi and Hwang, 2023](#); [Goodman et al., 2022](#); [Kim and Mark, 2023](#); [Lacasse et al., 2023](#)) and indicates a constraint to hemp adoption among older U.S. adults. Though we do not include a predictor for marijuana perceptions, our findings could reflect lingering public confusion and/or disapproval regarding hemp and marijuana ([Goel et al., 2023](#); [Rampold et al., 2021](#); [Wysota et al., 2022](#)), which would point to a need for improved clarity on the federal distinction between the two crops. Considering persistent association of age and hemp use, there is a need for further research and public education strategies to understand why older adults are averse to hemp and how the sector can reduce the stigma associated with its products. This would include all types of hemp-based products, including CBD.

In the meantime, efforts seeking to educate the public on hemp and its benefits should consider the age of their target audience. Age also highlights consistent consumer segmentation opportunities across hemp products that can be applied by the industry more broadly.

Though age has the same effect on CBD as other hemp-based product categories, the remaining background factors demonstrate varying effects across TPB constructs and product models. We do find some consistency of demographic influence on TPB constructs within products. Democrat respondents positively influence perceptions of CBD and personal care products. Female respondents negatively influence food and clothing perceptions, while perceptions of CBD and food are negatively influenced by BIPOC respondents. Demographic-based consumer segmentation appears to also be present within types of hemp products. The variation in demographic influence is not limited to CBD as compared to all other product types. Instead, the variability appears present across all categories, with personal care exhibiting the greatest difference in direct effects. This variability may reflect inherent product differences and highlights a need to treat hemp products differently when making production decisions and in hemp consumption research. CBD products appear to have a unique consumer base, as do all other types of hemp product types. Consumers of different fiber and grain products may not be uniform, which should be a consideration for policy efforts seeking to separate fiber and grain regulation from that of floral. The limited influence of demographics, along with TPB constructs, further signifies that other factors associated with consumer choice are more salient for hemp users.

Though hemp's agronomic potential and variety of plant-based products indicate that it could contribute to sustainable agriculture and economies, an absence of peer-reviewed literature presents a risk of uninformed producers and policy decision making, leading to poor outcomes and products consumers don't desire. The need to understand consumer perceptions and how they vary across hemp product types is compounded by an evolving regulatory environment that is considering relaxing restrictions and separating hemp floral regulation from that of fiber and grain (Johnson, 2023). This study applies the theory of planned behavior to explore the how perceptions and socio-demographic factors influence U.S. consumer behavior towards hemp products. We highlight areas where policy and marketing strategies can be uniformly applied across product contexts and where they should be distinguished by product type. Streamlined segmentation approaches are possible for age and attitude, but product-specific approaches may be necessary for the remaining TPB and socio-demographic. Findings offer a foundational understanding of consumer behavior towards hemp products to inform hemp policy, production, and future research.

6. Limitations and opportunities

This study provides a novel understanding of TPB in the context of hemp consumption research, but limitations remain. Despite our TPB constructs meeting model fit requirements, more survey questions could further improve the measurement model. In addition, our dependent variable is represented as a single survey question rather than a latent measurement. Using multiple questions to capture the intention to use hemp products may also strengthen future TPB applications. Using revealed behavior, such as hemp food product purchases (Kim and Mark, 2023), instead of intention as a proxy could highlight potential intention-behavior gaps and offer more robust insights for hemp stakeholders. Given the absence of explanatory power of SN and PBC, future research should consider other consumer choice motives that inform adoption. Expanded iterations of TPB that evaluate trust, the role of marijuana, risk, health, or sustainability measures may be relevant to our understanding of hemp.

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Corresponding author

Hannah Lacasse can be contacted at: hlacasse@uvm.edu