INTRODUCTION

Hemp (Cannabis sativa) has reemerged in the market landscape of the United States as a sustainable crop and product alternative. The crop's floral, grain, and fiber material can act as substitutes for synthetic fossil fuel-based ingredients, and create thousands of value-added products (Das et al., 2017; Langeveld et al., 2010; Popular Mechanics Magazine, 1938). Hemp can serve as a low energy crop, whose biomass can provide a myriad of bioenergy outputs (Finnan & Styles, 2013; Papadopoulou et al., 2015; Rehman et al., 2013). These characteristics make hemp a viable input for a bioeconomy, where renewable resources serve as the basis for value-added materials, products, and energy (Amaducci et al., 2015; McCormick & Kautoo, 2013; Tang et al., 2017).

Hemp production was reintroduced to the United States with the passing of the 2014 Farm Bill, which allowed for state-based research and pilot programs (Legitimacy of Industrial Hemp Research, 2014). The federal legalization of hemp in 2018 triggered national interest in its production and commercialization (Agriculture Improvement Act of 2018, 2018). The U.S. Department of Agriculture (USDA) reports that hemp acreage increased by nearly 350% from 2018 to 2019, with a focus on floral harvest for essential oil
and cannabidiol (CBD) production (Mark et al., 2020). CBD has been an appealing production prospect due to rising consumer demand and high economic returns (Mark et al., 2020; Mark & Snell, 2019). However, the report also points to the uncertainty of land availability, oversupply, market transparency, risk management, and government regulation that this nascent sector must manage in the coming years. An absence of peer-reviewed research and data on the hemp consumer market nationally have been identified as an active hurdle to addressing these challenges (Ellison, 2020; Mark et al., 2020). Knowledge on CBD demand is particularly crucial due to volatile prices and rigorous regulation (Mark et al., 2020). For some states, such as Kentucky and Colorado, the CBD market has already experienced price volatility since hemp’s legalization, with biomass prices peaking in July of 2019 at approximately $4.50 per percentage CBD per pound and dropping in January of 2020 to nearly 50 cents per percentage CBD per pound, threatening the resilience and longevity of producers (Mark, 2020). Thus, this study seeks to contribute to this gap in literature through an analysis of Vermont residents’ behavior toward hemp and hemp-based products, including CBD products, over time.

Vermont serves as a comparable lens from which to view hemp’s development in the United States. The state’s percentage growth for number of registrations and registered hemp acres from 2016 to 2019 is approximate to that of the United States as a whole (Figures 1 and 2). Vermont also shares similar production concerns expressed by the rest of the country, including fair pricing and market saturation (McCallum, 2019; Wallace Allen, 2019). By the end of the 2019 harvesting season, 50% of surveyed hemp growers did not have a buyer for their material (Vermont Agency of Agriculture Food & Markets, 2019). Given these challenges, registered acres and registrations have dropped from 2019 to 2020 in Vermont (Figures 1a and 2a).

Insight into consumer demand and behavior toward hemp-based products is critical to help direct risk management and production strategies for growers and processors (Mark et al., 2020). Understanding the hemp consumer will play an important role in constructing a robust and resilient industry. A 2019 survey identified market demand as the most highly anticipated research category for hemp producers (Ellison, 2020) and the USDA notes that market and economic research on national hemp production is absent (Mark et al., 2020). Although producers have been quick to adopt this innovative crop, there is scant peer-reviewed research on how consumers have responded to its resurgence. Research on internet searches in the United States reveals a rise in searches for CBD between 2014 and 2018, with search volumes increasing by 160% from 2017 to 2018 (Leas et al., 2019). Kolodinsky et al. (2020) find that consumer demand
for hemp-based products in Vermont may extend beyond CBD products, including clothing and personal care products. However, this is the only published, peer-reviewed literature on consumer behavior toward hemp in Vermont and in the United States more broadly to date. Industry derived data on consumer demand for hemp are largely focused on CBD products, with men and older consumers more likely to consumer CBD products (New Frontier Data, 2020a). Kim and Mark (2018) have also analyzed Nielsen Consumer Panel data to evaluate the influence of demographics on cereal, nuts, vitamins, and medications. Given hemp’s historic ties to marijuana, indication of consumer acceptance of hemp and their response to all types of hemp products on the market is critical to allow for educated production and marketing decisions (Malone & Gomez, 2019). This study builds this knowledge base through a comparison of 2019 and 2020 survey data of Vermont consumers on their support for hemp production, and familiarity with and use of hemp-based products. Given the timing of hemp’s federal legalization, Vermont’s hemp harvest period, and the data collection period, this study represents a comparison of consumer behavior between the 2019 and 2020 growing seasons.

2 | MATERIALS AND METHODS

2.1 | Materials

This study analyzes data collected by the University of Vermont’s Center for Rural Studies through a statistically representative telephone survey of Vermont residents. Approved by the Institutional Review Board at the University of Vermont, data were collected in February and March of both 2019 and 2020. Trained interviewers conducted the survey using computer-aided telephone interviewing. Respondents were chosen through random sampling from a list of Vermont landline and cell phone numbers. Respondents were randomly selected each year of data collection; thus, these data serve as cross-sectional samples where the identities of individual respondents cannot be discerned. To participate in the survey, respondents had to be current residents of Vermont and 18 years or older. Complete responses required for the logistic regressions conducted in this study ranged from 934 to 946 and results have a margin of error ranging from ±3.204% to ±3.184% with a confidence level of 95%. IBM® SPSS® Version 26 was used to conduct all statistical analyses.

2.2 | Methods

This study characterizes consumer behavior toward hemp and hemp products through three survey questions: support for industrial hemp production, familiarity with hemp-based products, and use of hemp-based products. Support for hemp production was collected through a five-point Likert scale, ranging from strongly opposed to strongly supportive. For the purposes of this study, this variable was recoded into those who are somewhat or strongly supportive compared to all other responses. Respondents were asked whether they were familiar with hemp CBD oil, hemp clothing or shoes, and hemp paper. General familiarity is defined as whether respondents indicated they were familiar with at least one of these three product categories. Respondents were also asked whether they use hemp-based products, including hemp CBD oil and hemp clothing. General familiarity is defined as whether respondents indicated that they use at least one category of product.

Sociodemographic data were collected for both survey years (Table 1). Age was measured continuously. Education is categorically measured into six levels of education. This sample appears to be more highly educated than Vermont census indications; those with a bachelor’s degree or higher being greater in our sample (53.4%) than state estimates (37.3%; United States Census Bureau, 2019). Female representation is higher in our sample (59.2%) than census estimates (50.6%; United States Census Bureau, 2019). Median household income for the state is $60,076 and those with an annual income of $50,000 or higher in our sample are 65.8% (United States Census Bureau, 2019). In order to determine urban vs. rural influence, a location variable was created to compare those residing in Chittenden County, the most populous Vermont county, with everyone else (Vermont Department of Health, 2019). Both our sample and census estimates indicate that 26% of Vermont residents reside in Chittenden County (United States Census Bureau, 2019).

An aim of this study is to determine whether the influence of demographic variables on consumer response to hemp and hemp products has changed between 2019 and 2020. Bivariate analyses were conducted to determine whether a statistically significant association exists for each dependent variable and a dummy variable for year (0 = 2019, 1 = 2020). A likelihood ratio test (LRT) was conducted for each dependent variable to determine the sufficiency of a nested model (Greene, 2012). A restricted model was created with each dependent variable and all demographic variables, including the dummy variable for year. An unrestricted model was also created for each dependent variable, all demographic variables, the year dummy, and all interaction terms. Interaction terms were created with the dummy variable for year and each independent variable. For categorical variables, the first category was used as the reference group to avoid perfect multicollinearity. A LRT was used to determine whether structural change was influenced by respondent characteristics.
A likelihood ratio (LR) statistic was computed based on the log-likelihood value for the restricted and unrestricted models:

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LR = 2(L_{ur} - L_r).
\]

The resulting LR statistic has an approximate chi-square distribution under the null hypothesis, with a critical value of 95%. If we fail to reject the null hypothesis that the restricted model was significantly different from the unrestricted model, then only the restricted model was analyzed to determine the presence of statistically significant structural change from 2019 to 2020.

3 | RESULTS

The majority of respondents in both survey years are supportive of hemp production in Vermont; however, there is no statistically significant association between support and year (Table 2). Significantly more respondents are familiar with hemp-based products in 2020 compared with 2019 (85.3%) vs. 96.8%. The majority of respondents are familiar with hemp CBD oil and hemp clothing in both years, with significantly more being familiar in 2020. Familiarity with hemp paper has risen from 35.0% in 2019 to 61.6% in 2020. General use of hemp-based products has risen from 32.6% in 2019 to 54.7% in 2020. Use of hemp CBD and hemp clothing specifically have also risen from 2019 to 2020. All dependent variables for familiarity and use are significantly associated with year.

Likelihood ratio test results for those supportive of hemp production in Vermont lead us to fail to reject the null hypothesis that the influence of demographic variables on hemp support did not significantly change over time \((\chi^2(16) = 16.539, p = 0.420)\). Logistic regression results for the restricted model reveal that year is not a statistically significant predictor of hemp support \((p = 0.718)\) (Table 3). Six sociodemographic variables are significantly associated with support. Age is negatively associated with hemp support, while income of $50,000–$75,000 per year, income of $75,000–$100,000 per year, Democrat affiliation, Independent affiliation, and Progressive affiliation are positively associated with hemp support.

Results for the LRT for general familiarity with hemp-based products lead us to fail to reject the null hypothesis that the influence of demographic variables on general familiarity with hemp did not significantly change over time \((\chi^2(16) = 16.539, p = 0.420)\). Logistic regression results for the restricted model reveal that year is a statistically significant predictor of general familiarity \((p = 0.718)\) (Table 3). Six sociodemographic variables are significantly associated with support. Age is negatively associated with hemp support, while income of $50,000–$75,000 per year, income of $75,000–$100,000 per year, Democrat affiliation, Independent affiliation, and Progressive affiliation are positively associated with hemp support.
significant predictors of general familiarity. Older respondents are less likely to be generally familiar with hemp-based products than younger respondents by 0.943 percentage points ($p < 0.001$) and those with an income higher than $100,000 per year are 3.324 times more likely to generally familiar than those with an income of less than $25,000 per year ($p = 0.001$). Respondents in 2020 were 3.587 times more likely to be familiar with hemp-based products compared to 2019 ($p < 0.050$).

Results from the LRTs for familiarity with hemp CBD oil, hemp clothing, and hemp paper lead us to fail to reject all null hypotheses. The influence of demographic variables on familiarity with hemp CBD oil ($\chi^2(16) = 20.095$, $p = 0.220$), hemp clothing ($\chi^2(16) = 11.300$, $p = 0.790$), and hemp paper ($\chi^2(16) = 12.058$, $p = 0.740$) did not significantly change over time. Results of the logistic regressions of the restricted models for familiarity with each hemp product were significantly associated with year, with

### TABLE 3 Logistic regression results for those supportive of hemp production in Vermont ($n = 940$)

| Variable          | Definition                          | Exp ($B$) | SE   | df |
|-------------------|-------------------------------------|-----------|------|----|
| Age               | Continuous                          | 0.989*    | 0.006| 1  |
| Education         | Less than high school diplomaa      | 0.623     | 0.524| 1  |
|                   | High school diploma or GED          | 1.024     | 0.536| 1  |
|                   | Some college completed              | 1.156     | 0.570| 1  |
|                   | Associates or technical degree      | 1.182     | 0.533| 1  |
|                   | Bachelor’s degree                   | 0.729     | 0.540| 1  |
|                   | Postgraduate or greater             | 0.816     | 0.173| 1  |
| Income            | Less than $25,000/yeara             | 1.426     | 0.273| 1  |
|                   | $25,000–$50,000/year                | 1.806*    | 0.288| 1  |
|                   | $50,000–$75,000/year                | 2.443**   | 0.337| 1  |
|                   | Greater than $100,000/year          | 1.266     | 0.282| 1  |
| Political affiliation | Republicana                   | 2.629*** | 0.249| 1  |
|                   | Democrat                            | 2.821*** | 0.247| 1  |
|                   | Independent                         | 6.277*** | 0.455| 1  |
|                   | Not politically affiliated           | 0.946     | 0.253| 1  |
| Location          | Chittenden County                   | 0.862     | 0.190| 1  |
| Year              | 2020                                | 0.942     | 0.166| 1  |
| Constant          |                                     | 3.070     | 0.657| 1  |

Note: Degrees of freedom for all variables are equal to 1.

*Significant at $p < 0.050$; **Significant at $p < 0.010$; ***Significant at $p < 0.001$.  

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**TABLE 2** Bivariate results for support ($n = 1177$); general familiarity with hemp-based products ($n = 1217$); and use of hemp-based products ($n = 1217$); and general use of hemp products ($n = 1217$)

| Year | Supportive of hemp production | General familiarity | Familiarity with hemp CBD oil | Familiarity with hemp clothing | Familiarity with hemp paper |
|------|-------------------------------|---------------------|-------------------------------|--------------------------------|----------------------------|
| 2019 | 75.9                          | 85.3                | 78.5                          | 70.4                           | 89.2                       |
| 2020 | 76.0                          | 96.6                | 95.3                          | 80.2                           | 90.2                       |

Note: Degrees of freedom for all variables are equal to 1.

References:

- CBD, cannabidiol.
- aReference category.
Respondents with an income higher than $100,000 per year were 2.559 (p = 0.020) and 1.938 (p = 0.036) times more likely to be familiar with hemp CBD oil and hemp clothing, respectively. Respondents who identified as Progressives were 2.002 (p = 0.030) times more likely to be familiar with hemp paper than Republican respondents.

Likelihood ratio test results for general use of hemp-based products lead us to fail to reject the null hypothesis that the influence of demographic variables on general use did not significantly change over time ($\chi^2(16) = 15.322, p = 0.500$). Logistic regression results for the restricted model reveal that year is a statistically significant predictor of general use of hemp products ($p < 0.001$; Table 6). Two categories of demographic variables are significant predictors of general hemp use: respondents with an Independent and a Progressive political orientation are 1.861 ($p = 0.005$) and 2.640 ($p = 0.002$) times more likely to use hemp products, respectively, than Republican respondents.

We also reject the null hypothesis that the influence of sociodemographic variables on use of both hemp CBD oil ($\chi^2(16) = 7.217, p = 0.970$) and hemp clothing ($\chi^2(16) = 21.058, p = 0.180$) did not significantly change between 2019 and 2020. Logistic regression results for the restricted models for use of hemp CBD oil and hemp clothing were both significantly associated with year, with respondents being 2.884 ($p < 0.001$) and 2.103 ($p < 0.001$) times more likely to use these products in 2020 compared to 2019 (Table 6). For use of hemp CBD oil, respondents with an Independent political orientation were 1.746 times more likely to use hemp products, respectively, than Republican respondents. For use of hemp clothing, respondents with Progressive and Independent political orientations were 2.485 ($p = 0.006$) and 3.445 ($p = 0.002$) times more likely to use hemp clothing, respectively.

### 4 | DISCUSSION

Hemp has been reintroduced to the production and market landscapes of the United States. Registered acreage is growing, processors are investing, and more innovative products are being researched and becoming accessible to consumers. Hemp has been touted as a sustainable and environmentally friendly crop, with thousands of potential products. However, the time and attention given to hemp have not been accompanied by evidence-based, peer-reviewed research on consumer segmentation and demand for hemp-based products. Now that hemp has been federally legalized and theoretical limitations, such as price volatility, oversupply, and risk management, are now experienced challenges, such information is critical to inform production and marketing strategies to enable a robust and resilient sector. Through a case study of Vermont residents, results offer a reference for consumer
response and behavior toward hemp in the first year of federal legalization.

Results reveal that the association between demographic characteristics and support, awareness, and use of hemp and hemp-based products has not significantly changed over time. However, significant associations with demographic variables and support, awareness, and use exist across both survey years. Those with higher incomes were more likely to support hemp production than those in the lowest income bracket. This may be reflective of a “not in my backyard” mentality, where those with higher incomes are able to avoid proximity to hemp fields due to odor or drug-related concerns, while lower income households may not have that ability (Németh & Ross, 2014). Those in the highest income bracket were also more likely to be generally familiar with hemp products. This may support previous studies that find income is positively associated with hemp purchases, indicating that hemp-based products are more expensive compared to conventional products (Kim & Mark, 2018). Use is not significantly associated with income and may indicate that there is a more complex relationship with hemp consumption and demographic variables. When compared to other industry data, this study supports findings regarding high consumer awareness of CBD products (New Frontier Data, 2020b). This study does not support industry findings that gender is a significant predictor of hemp CBD use (New Frontier Data, 2020a).

Independent, Progressive, and Democrat respondents were more likely to support hemp production than Republican respondents. Progressive and Independent respondents were also more likely to be general users of hemp-based products, as well as users of hemp clothing. Independent political orientation was associated with use of hemp CBD oil. These results support findings in a 2019 case study of Vermont residents, and further demonstrate continued political polarization of hemp due to the stigma related to drugs and marijuana (Kolodinsky et al., 2020). Public education on hemp’s unique traits and distinction from marijuana may help to build confidence in consumers unwilling to try hemp-based products due to this false stigma. Age was the only consistent demographic predictor of hemp familiarity, both generally and with hemp CBD oil, hemp clothing, and hemp paper. Older

### Table 5

Logistic regression results for familiarity with specific hemp-based products (n = 946)

| Variable | Definition | Hemp CBD oil | Hemp clothing | Hemp paper |
|----------|------------|--------------|---------------|------------|
|          |            | Exp (B)     | SE           | Exp (B)    | SE         | Exp (B)    | SE         |
|          |            | 0.960***    | 0.009        | 0.975***   | 0.006      | 0.965***   | 0.005      |
| Age      | Continuous |             |              |            |            |            |            |
| Education | Less than high school diploma a | 1.168       | 0.657        | 1.599      | 0.500      | 0.996      | 0.504      |
|          | High school diploma or GED   | 1.201       | 0.666        | 2.382      | 0.512      | 1.782      | 0.508      |
|          | Some college completed       | 2.106       | 0.745        | 2.502      | 0.549      | 0.924      | 0.532      |
|          | Associates or technical degree | 1.912      | 0.675        | 3.783*     | 0.515      | 1.200      | 0.502      |
|          | Bachelor's degree            | 2.128       | 0.697        | 4.892**    | 0.536      | 1.148      | 0.510      |
| Gender   | Female      | 0.989       | 0.244        | 1.228      | 0.190      | 0.677**    | 0.148      |
| Income   | Less than $25,000/year a    | 2.355*      | 0.359        | 1.543      | 0.287      | 0.785      | 0.253      |
|          | $25,000–$50,000/year         | 1.662       | 0.352        | 1.352      | 0.293      | 0.841      | 0.259      |
|          | $50,000–$75,000/year         | 1.675       | 0.411        | 1.623      | 0.342      | 0.763      | 0.281      |
|          | $75,000–$100,000/year        | 2.559*      | 0.403        | 1.938*     | 0.316      | 0.655      | 0.257      |
|          | Greater than $100,000/year   |             |              |            |            |            |            |
| Political | Republican a     | 1.371       | 0.343        | 1.097      | 0.279      | 0.935      | 0.229      |
|          | Democrat       | 1.565       | 0.338        | 1.439      | 0.276      | 1.287      | 0.223      |
|          | Independent    | 3.603       | 0.675        | 2.047      | 0.475      | 2.002*     | 0.319      |
|          | Progressive    | 1.064       | 0.379        | 0.792      | 0.295      | 0.611      | 0.256      |
|          | Not politically affiliated |            |              |            |            |            |            |
| Location | Chittenden County   | 1.001       | 0.275        | 0.960      | 0.216      | 0.966      | 0.165      |
| Year     | 2020          | 3.909***    | 0.287        | 2.824***   | 0.201      | 2.408***   | 0.143      |
| Constant |             | 17.993      | 0.921        | 2.566      | 0.665      | 6.155      | 0.606      |

Note: Degrees of freedom for all variables are equal to 1.
Abbreviation: CBD, cannabidiol.
*aReference category.
*Significant at p < 0.050; **Significant at p < 0.010; ***Significant at p < 0.001.
respondents are less likely to be familiar with these products than younger respondents. This points to segmented education opportunities to broaden knowledge of hemp products in order to grow their accessibility and use in the market.

Noteworthy is the finding that respondents were more likely to be general users of hemp, as well as specific users of hemp CBD oil and hemp clothing in 2020 compared to 2019. This could be the result of the widespread introduction and adoption of hemp-based products into the market. However, this may also be due to differences in recall strategy between survey years, where the 2020 survey provides a list of hemp products based on responses to the open-ended 2019 survey. These recall differences are a limitation of this study.

This study finds that awareness and use of hemp-based products among Vermont respondents have experienced structural change over time in its first 2 years of federal approval. Although demographic variables did not significantly change over time, we find political affiliation to be a significant predictor of hemp use. Remaining demographic characteristics were found to be inconsistent predictors of hemp familiarity and use. These findings support previous research and contribute to the indication that consumer preference for hemp-based products may be influenced by attitudes and opinions (Kolodinsky et al., 2020). Future research should include information on consumer motivations for purchasing hemp products that go beyond demographic characteristics and reach a sample wider than a single state.

USDA grant 2020-67024-30955—Economic Impacts of the Hemp Industry: Opportunities for Rural Development provides funding to conduct a national consumer study in 2021. Recommendations derived from this study will be contributed to the creation of the survey.

**DATA AVAILABILITY STATEMENT**

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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**TABLE 6** Logistic regression results for general use of hemp-based products ($n = 946$) and for use of hemp CBD oil ($n = 934$) and hemp clothing ($n = 934$)
