ABSTRACT

Approaches for raising calves vary across commercial dairy farms and relate to behavioral opportunities and animal welfare. The objectives of this study were to evaluate how US dairy producers and calf managers perceive 1) welfare implications of varying management practices (including social housing and milk allowance) and behaviors in dairy calves, and 2) aspects of the human-animal relationship in calf rearing and relationships with on-farm management and personal calf handling habits. Survey questions were primarily quantitative (e.g., Likert scales) and addressed how common calf management practices and observed calf behaviors were related to aspects of welfare, including calf health and comfort. We additionally posed questions addressing respondent habits, management protocols, and perceptions related to human-animal interaction. Responses from 93 dairy producers and calf managers were collected via digital surveys. Social housing was viewed as being generally positive for both calf comfort and health, although this view was stronger with respect to calf comfort. Respondents from farms using social housing (56%) had more positive perceptions of social housing, viewed social play as being associated with better calf comfort and health, and considered access to other calves and “freedom to express natural behavior” as being more important for calves, compared with respondents from farms not providing social housing. Providing greater milk allowances (>7.6 L/d) was viewed as being good for both calf comfort and health, although respondents from farms providing these milk allowances (59%) had more positive perceptions than those who provided lesser allowances. Abnormal oral behaviors were viewed as being associated with both poor calf comfort and health. The welfare importance of various resources which may reduce abnormal oral behaviors (including hay and brushes) was perceived more ambiguously, although respondents from farms providing these resources, compared with those who do not, generally viewed them as more preferred by calves. We observed a positive relationship between how respondents perceived the human-animal bond (i.e., that calves enjoy contact with humans) and stated personal behavior related to calf contact (frequency of contacting calves to scratch or pet them). Respondent demographics were not related to perceptions of the human-animal relationship, but respondents identifying as female described more frequent positive calf interactions. Described aspects of human-animal interactions were not related to implementation of social housing on-farm. Job satisfaction was positively related to perception of the human-animal relationship. Overall, these results suggest that most calf management personnel place a high value on calf welfare, although farms implementing social housing appear to place a greater value on subjective calf well-being and individual perceptions of animal welfare may depend on practical experience.

Keywords: survey, calves, animal welfare, social housing

INTRODUCTION

Concern for animal welfare currently drives research efforts and changes in how dairy cattle are reared and managed. Approaches to rear ing dairy calves have seen shifts toward accommodating natural behavior and alleviating negative affective states. Key topics of concern have included social housing for calves, which allows for social behavior and stress buffering effects of social contact, and providing higher milk allowances, to alleviate hunger (Costa et al., 2019). The concept of animal welfare broadly encompasses aspects of an animal’s opportunity for motivated natural behavior, affective state, and health and basic functioning (Fraser, 2009). Given that the concept of animal welfare encompasses multiple factors, changes in management may then present trade-offs, either real or perceived, between facets of an animal’s welfare. For example, despite behavioral benefits of social housing, disease risk in group-housed calves is often stated as a concern (despite mixed research findings on this topic; reviewed by Costa et al., 2016).
While managing calves to reduce morbidity and mortality is a key priority, the intersection of calf behavioral expression and affective state is an area of growing research. Animal affective state may be assessed indirectly through measures of preference or motivation for resources (e.g., motivation to access another calf; Ede et al., 2022) as well as cognitive approaches (e.g., effects of social housing on judgement bias; Bučková et al., 2019). Current research in this area particularly supports benefits of social contact but also supports benefits of physical enrichment (Neave et al., 2021). Additionally, accommodating behavioral needs is related to reducing the expression of abnormal behaviors. For example, behaviors such as cross-sucking and pen-directed sucking are reduced when calves are provided opportunities for more natural feeding behavior (including sucking and consuming forage; Horvath and Miller-Cushon, 2017; Salter et al., 2021; Downey and Tucker, 2023) and reared in generally more complex environments (e.g., providing social contact; Doyle et al., 2022, brush access; Horvath et al., 2020, other varied enrichments; Zhang et al., 2021).

Despite increasing research focus in this area, the implementation of calf management practices with implications for animal welfare is widely variable on-farm, suggesting a need to better understand how dairy producers perceive relationships between calf management, behavioral expression, and welfare. Further, the human-animal relationship may have implications for both calf and employee well-being, considering evidence that it is related to dairy cattle behavior and employee attitudes and job satisfaction (des Roches et al., 2016). Evidence also suggests a relationship between calf management and human-animal interaction, with socially-housed calves directing more attention toward humans than individually housed calves (Duve et al., 2012; Doyle et al., 2022).

We conducted a survey to gain knowledge about US producer perceptions of how common calf management practices and observed behaviors are related to calf welfare, and perceptions and practices related to the human-animal relationship. First, we assessed perceptions of how calf management (focusing on social housing and milk feeding level, practices that are variable and of current focus in the dairy industry) affects aspects of calf welfare, and how calf behavioral expression (including abnormal behaviors, such as cross-sucking, as well as natural behaviors, such as social behavior and play) are associated with aspects of calf welfare. To assess perception of welfare, we specifically asked about calf health/performance, to gauge perception of biological functioning aspects of welfare, and calf comfort, which was intended to reflect perception of the calf’s subjective emotional experience or affective state. We predicted that certain behaviors and practices (social housing of dairy calves specifically) may be perceived as creating a conflict between calf biological functioning and affective state. We additionally assessed whether perception of how behavioral expression or calf management are related to calf welfare depends on respondents’ observations of specific calf behaviors or current management factors on their farms.

Second, we explored perceptions of the human-animal relationship in calf rearing and how those perceptions relate to on-farm management, respondent personal habits related to calf interaction, and respondent job satisfaction. We predicted that the nature of personal interaction with calves described by respondents may be related to perception of the human-animal relationship and job satisfaction more generally. We were additionally interested in how use of social housing for dairy calves may be related to aspects of the human-animal relationship and job satisfaction. Finally, we also wished to identify areas where resources and education about dairy calf behavior and welfare were desired by producers.

MATERIALS AND METHODS

This project was approved by the University of Florida Institutional Review Board (no. 202102420).

Research Team and Reflexivity

The survey was designed by a graduate research assistant (SD), a MS candidate at the University of Florida in the Department of Animal Sciences at the time, and their primary advisor (EM). SD had broad interest in aspects of human-animal interaction and EM contributed expertise in dairy calf behavior, management, and welfare. Input into survey design, distribution, analysis, and interpretation of results was provided by an internal advisory committee member with expertise in animal welfare and survey methods (CW) and an external collaborator with expertise in dairy cattle welfare and previous experience conducting stakeholder surveys (JV). Before participation, study participants were informed that this survey was being conducted to gather information on producer perceptions of dairy calf behavior and well-being, with the goals of 1) gaining knowledge about common husbandry practices and producer perceptions of how these practices influence calf behavior, comfort, and health, and 2) identifying areas where we can assist in providing resources and education about animal behavior and well-being. No personal relationships were established with participants.
Survey Population and Delivery

This survey was distributed using Qualtrics software online throughout late fall of 2021 and spring of 2022. Recruitment was through online communication channels (i.e., email, social media, producer-oriented newsletters, per similar methods to Medrano-Galarza et al., 2017) using advertising material stating: “we are seeking input from dairy producers on how calf management affects behavior and health.” Eligibility criteria of participants included ability to read and understand English, being over 18 years of age, and agreement with the statement “I verify that I currently work for a dairy farm that manages pre-weaned calves.”

Given the exploratory nature of this survey, no formal sample size calculation was completed and data were collected from a convenience sample of producers representative of the population responsive to academic outreach and extension programming as is common for survey-based research (e.g., see Saraceni et al., 2021). Distribution was also facilitated by the Dairy Cattle Welfare Council mailing list (including producers, academics, veterinarians, and industry representations), which may have skewed respondents toward those with an above average attention toward the improvement of animal welfare. Respondents were not compensated for completing the survey.

Survey Design

The survey (Supplementary Material S1) was divided into 4 sections focused on: 1) perception of calf “health/performance” and “comfort,” 2) farm management and behavioral observation, 3) human-animal interaction, and 4) respondent demographics and preferences for educational resources. A consistent set of questions was provided to all respondents (with no branching logic). The survey was piloted with 6 respondents (producers and calf personnel) before distribution.

The first section of the survey (6 multi-part questions with quantitative data) addressed the primary outcomes of interest, seeking to characterize subjective views on the links between calf behavior and aspects of welfare. Respondents were asked about their perception of how various behaviors and management practices were related to either calf “health/performance” or “comfort.” No further definitions were provided for these terms. Calf comfort was the term selected as an intended proxy for gauging perceptions related to calf affective state/subjective emotional experience related to the behavior or management practice in question. A total of 6 behaviors were included: abnormal oral behaviors (options listed as: “cross-sucking,” “sucking on parts of the pen,” and “eating or licking bedding”), self-grooming (listed as: “licking or scratching coat”), and social behaviors (options listed as: “calves running or playing together,” and “calves lying close together”). These behaviors were selected to broadly encompass a range of commonly-reported behaviors which may be considered both positive (e.g., play; Mintline et al., 2013) and negative (e.g., abnormal oral behavior; Horvath and Miller-Cushon, 2017). A total of 5 management factors were addressed, including milk feeding level (“providing >8 quarts/d (or 7.6 L/d) of milk or milk replacer”); quarts were chosen as the most familiar unit of measurement for US respondents, where 1 quart = 0.95 L), social housing (“pair or group housing with full contact with other calves”), enrichments (“providing objects for interaction or play” and “providing brushes (rotating or manual)”), and human interaction (“contact with farm staff”). We were particularly interested in practices which remain varied and divisive within the dairy industry today, despite evidence to support their benefits, including social housing and providing greater milk allowances (Roche et al., 2013). For this question, 8 quarts/7.6 L of milk was chosen as a conservative benchmark for gauging perception of elevated milk feeding levels (approaching 20% of a calf’s birth weight) given evidence to suggest that most producers are feeding less than this amount (other recent survey data is lacking; reviewed by Roche et al., 2023). Over 2 questions, respondents were asked to indicate how they thought each behavior and management factor affected calf health/performance (a 5-point scale from “very bad for calf health/performance” to “very good for calf health/performance”). They were similarly asked over 2 questions how they thought each management factor affected calf comfort or behavior (a 5-point scale from “very bad for calf comfort or behavior” to “very good for calf comfort or behavior”), and how they thought each behavior was associated with (vs. affected) calf comfort, with the wording adjusted to be more general than the question about management to encompass possible bidirectional relationships between positive affective state and behavioral expression (a 5-point scale from “associated with very bad calf comfort” to “associated with very good calf comfort”).

Opinions of the importance of behavioral opportunities, often considered as enrichments for dairy calves, were further evaluated in a question asking about perception of calf preferences for accessing certain resources (other calves, brushes, a dummy teat, hay, and other objects to lick/suck on), with respondents asked to indicate whether each resource was “preferred,” “something preferred” or “not preferred” by calves. Finally, more general perception of animal welfare was assessed in a question adapted from the Five Freedoms concept of defining welfare (considered in the context of other
Respondents were asked to indicate how commonly they observed a list of behaviors in milk-fed calves (4-point scale: “never,” “rarely,” “sometimes,” “frequently”), with options corresponding with the behaviors addressed in the first section of the survey, including “cross-sucking,” “sucking on parts of the pen,” “eating or licking bedding,” “licking or scratching coat,” “calves running or playing together,” and “calves lying close together.” For further analysis, described below, these responses were dichotomized as those that reported observing the behavior commonly (defined as those that indicated “sometimes” or “frequently”) or not (those that indicated “never” or “rarely”).

The third section of the survey (10 questions) addressed aspects of human-animal interaction. Respondents were asked how often (4-point scale: “never,” “rarely,” “sometimes,” or “often”) they engaged in certain types of calf contact (including: “contacting calves to scratch or pet them,” “allowing calves to suck on fingers,” “allowing calves to sniff” them, “talking to calves,” and “giving calves a name”), adapted from some similar questions posed by des Roches et al. (2016). For further analysis, described below, these responses were dichotomized for each type of interaction as those that reported performing it “often” and those that did not (those that indicated “never,” “rarely,” or “sometimes”). Respondents were also asked to estimate frequency of routine handling of pre-weaned calves (by any staff on the farm), and these responses were subsequently dichotomized into frequent handling (defined as farms that handle calves more than once a week) and infrequent handling (those that handle calves weekly or less).

To gain insight into personal perspectives on aspects of the human-animal relationship in calf rearing, respondents were asked to indicate their level of agreement (5-point Likert scale) with the following statements: “Dairy calves enjoy contact with the people who care for them” and “Dairy calves are able to recognize the people who care for them.” Respondents were also asked to indicate their agreement with the statement “I enjoy taking care of dairy calves” and to indicate how difficult they perceived calf handling to be (5-point Likert scale, from “extremely difficult” to “extremely easy”). These questions were modeled after questions posed by (des Roches et al., 2016). More general job satisfaction was assessed through 2 questions where respondents were asked to indicate their level of agreement (5-point Likert scale) with the statements: “I get along with my coworkers” and “I feel satisfied with my job,” modeled after questions posed by (Coleman et al., 1998).

The final section of the survey (9 questions) addressed demographics, with questions collecting data on state, age (categorical response: 18–25, 26–35, 36–45, 46–55,
56–65, 66+) gender, education level, role on the farm (owner, herd manager, calf manager, calf care staff, or other), and how much longer they anticipated working in the dairy industry. Education level was assessed as the highest level of education received (categorical response: less than high school, high school graduate, trade school, some college, Associate degree (2-year degree), Bachelor’s degree (4-year degree), Graduate degree (MS or PhD), professional graduate degree (e.g., DVM), and other). According to the approach taken by Saraceni et al. (2021), roles on the farm were clarified by categorizing respondents as “managers” if they had any managerial role (herd managers, calf managers, and any respondents who indicated “other” but had a managerial or influencing role, including consultant (n = 1), veterinarian (n = 4), or similar roles (assistant manager,” “assistant herdsmen”)). Respondents were additionally asked if they were interested in educational resources related to calf behavior and handling, who they would feel most comfortable receiving information from (multiple choice options: researchers/animal behaviorists, veterinarians, extension agents, business leaders in the agriculture industry, or other), and what information would be must helpful (open text response).

**Statistical Analysis**

Survey responses were exported from Qualtrics into Microsoft Excel, which was used to calculate descriptive statistics. A total of 93 survey responses were included for analysis after excluding 30 responses, which were either largely incomplete or from outside our study region (United States). Answering all questions was not required, but responses included in the final analysis were primarily fully answered (9 responses were not fully complete but were included in the analysis for completed sections). Where percentages were calculated to describe the data, the denominator was the total number of responses per specific question (which ranged from 84 to 93).

For descriptive purposes, current implementation of practices of interest (social housing, feeding ≥7.6 L milk/d, teat feeding, provision of hay, and provision of brushes or other toys) was compared between farm size categories (<100 calves born per year (small), 100–499 calves born per year (medium), > 500 calves born per year (large)) using the Freeman-Halton extension of the Fisher’s exact test (for 2 by 3 contingency tables; Proc Freq in SAS, SAS v. 9.4, SAS Institute Inc.) . Indication of different factors as being influential in housing practices were compared between respondents whose farms provided social housing and those that did not using Fisher’s Exact Tests. To evaluate potential welfare tradeoffs, differences in equality of distribution were tested between scores for perception of calf health/performance (5 point score from: “very bad for calf health/performance” to “very good for calf health/performance”) and calf comfort (5 point score from: “associated with very bad calf comfort” to “associated with very good calf comfort”) using Kolmogrov-Smirnov tests (within the NPAR1WAY procedure of SAS), for each behavior (cross-sucking, pen-directed sucking, eating bedding, self-grooming, social play, and social lying) and management factor (feeding ≥7.6 L milk/d and social housing). We additionally examined differences in equality of distribution for each behavior between respondents that reported commonly observing the behavior and those that did not. For eating bedding, we performed a post hoc analysis to test differences in equality of distribution (Kolmogrov-Smirnov tests) between respondents who provided straw bedding vs. other options which are less safe for ingestion (e.g., sand bedding), and differences in reports of commonly observing eating bedding between those who provided straw or other bedding options (Fisher’s Exact Test). For management factors, we examined differences in equality of distribution between respondents who indicated that their farm was implementing that management practice, at least for some calves, and those that were not.

The relationship between perceived calf preference for various resources (indicated as “preferred,” “somewhat preferred,” or “not preferred” by calves) and on-farm management practice (those providing the resource in question and those not) were evaluated using the Freeman-Halton extension of the Fisher’s exact test (for 2 by 3 contingency tables). The majority of respondents considered each of the questions based on the Five Freedoms to be “very important,” and so these responses were converted to a binary outcome (1 = “very important,” 0 = “somewhat important,” “slightly important,” or “not important”). We then tested whether perception of each of the Five Freedoms as being “very important” differed between respondents from farms currently using management factors of interest (feeding ≥7.6 L milk/d and social housing) using Fisher’s exact tests.

Differences in equality of distribution for questions related to human-animal interaction (agreement with the statements “Dairy calves enjoy contact with the people who care for them” and “Dairy calves are able to recognize the people who care for them”) were tested (Kolmogrov-Smirnov tests) between respondents who reported different habits when handling calves (“often” contacting calves to scratch/pet them, allowing calves to suck fingers, talking to calves, or naming calves, vs. “never,” “rarely,” or “sometimes” performing these calf-directed behaviors) and different on-farm protocols for
calf handling (handling calves more than once a week vs. weekly or less). We additionally analyzed effects of social housing on agreement with these statements related to human-animal interaction and reported habits when handling calves, by similarly testing differences in equality of distribution for these questions.

Using multivariate general linear models (Proc GLM in SAS) we assessed how participant demographics (gender, age, education, and role on the farm) are related to these reported habits when handling calves and agreement with statements describing the human-animal relationship. All respondents who answered questions related to demographics selected either “female” or “male” as their gender, and so only those categories were included for analysis. Age was included as a binomial variable reflecting original age ranges respondents selected. To increase comparability between categories, education was included in this analysis as a binary variable reflecting completion of a 4-year college degree and role on the farm was included as a binary variable by dichotomizing respondents into owners and other on-farm roles (with thresholds for dichotomization defined by the distribution of respondent data). We additionally analyzed the relationship between perceptions of the human-animal relationship (sum of responses to “Dairy calves enjoy contact with the people who care for them” and “Dairy calves are able to recognize the people who care for them”) and job satisfaction (sum of responses to “I get along with my coworkers” and “I feel satisfied with my job”) using Spearman rank-order correlation (Proc Corr in SAS).

RESULTS

Respondent Demographics and Calf Management

Responses came from 24 states, with Wisconsin the most represented state (20 responses; 24%) followed by Pennsylvania (8 responses), Florida (7 responses), New York (6 responses), Ohio (6 responses) and North Carolina (5 responses). Remaining responses came from: Arizona (1 response), California (2 responses), Colorado (2 responses), Connecticut (1 response), Georgia (1 response), Idaho (1 response), Illinois (1 response), Indiana (2 responses), Iowa (1 response), Kansas (1 response), Maine (3 responses), Michigan (3 responses), Minnesota (3 responses), Mississippi (3 responses), Nebraska (1 response), New Hampshire (2 responses), Texas (2 responses), and Virginia (1 response). Respondents indicated that the number of heifer calves born per year on their farm ranged from 20 to 13,000 (median = 250), with 13% small (<100 calves born per year), 37% medium (100–499 calves born per year), and 32% large farms (>500 calves born per year).

Of those respondents who answered demographics questions (n = 84), 74% described themselves as female and 26% as male. The age distribution was 16% between 18 and 25, 24% between 26 and 35, 20% between 26 and 45, 12% between 46 and 55, and 12% over 56 years of age. The plurality of respondents were classified in a managerial role (49%; with 48% of those respondents specifically selecting “calf manager”), 44% were owners or co-owners, and 7% were calf care staff (2% selected “other” with no clarification and were excluded from this summary). A plurality of respondents had a Bachelor’s/ 4-year college degree (37%) or an Associate/2-year college degree (17%), followed by some college with no finished degree (16%), a professional graduate degree (e.g., DVM; 15%), a graduate degree (MS or PhD; 11%), and high school (4%).

The majority of respondents (59%) reported that 4-week-old calves received ≥8 qt/d (7.6 L/d) of milk or milk replacer. Of these, 57% reported that 4-week-old calves received more than 9 quarts/d (8.6 L/d) of milk (approaching current best practice recommendations of 20% body weight; Khan et al., 2011a). The remaining 41% of responses (feeding <7.6 L/d) indicated a median of 6 quarts/d (5.7 L/d) fed (minimum 4 quarts/d, or 3.8 L/d). The percentage of farms providing ≥7.6 L/d did not vary between farm size categories (P = 0.28). Most respondents (75%) indicated that milk or milk replacer was fed via a teat (using a bottle, teat bucket, or autoteeder), at least some of the time, with the remaining 25% of respondents indicating that calves were only fed using an open bucket. Many respondents indicated that bottles were provided (57%) with teat buckets used less often (20%). Autoteeders were used according to 14% of respondents. Of those respondents describing that milk was fed by a teat, 31% also reported that milk was fed from an open bucket, suggesting a combined approach to delivering milk during the milk-feeding stage. Provision of milk through a teat did not differ between farm size categories (P = 0.90). Only a few respondents indicated that calves were provided resources which may provide enrichment (brushes: 3%; hanging balls or other toys: 5%). Respondents indicated that forage (“hay/straw or other forage”) was provided to milk-fed calves on 47% of farms. Providing forage varied between farm size categories (P = 0.01), with respondents indicating that forage was provided to calves on 77% of small farms (<100 calves born per year), 49% of medium farms (100–499 calves born per year), and 28% of large farms (over 500 calves born per year).

Most respondents (56%) stated that calves were routinely housed with some form of social housing; in pairs (24%), groups <8 (28%), groups ≥8 (18%), or with dam/nurse cow (2%). Of those utilizing some form of social housing, 75% also reported commonly using
some type of individual housing and 23% reported using more than one type of social housing (pair and group housing, or groups of both <8 and ≥8). Of those not using social housing, 68% reported that calves were housed individually within visual but not physical contact with other calves, 35% reported that calves were housed individually with physical contact with other calves, and 5% reported that calves were housed with no visual or physical contact with other calves. There was a numerical trend for the use of social housing to vary between farm size categories ($P = 0.09$), with respondents indicating 31% adoption on small farms, 65% adoption on medium farms, and 50% adoption on large farms. Bedding material was described as straw or straw in combination with “other” by 62% of respondents, straw and sand by 15% of respondents, sand or a combination of sand and “other” by 9% of respondents, only “other” by 7% of respondents, mats or a combination of mats and “other” by 5%, and no bedding by 2% of respondents.

Respondents’ evaluation of different factors as influential in the decision to house calves according to current management is shown in Figure 1, with responses divided between respondents from farms using social housing and those not. Consideration of factors related to calf behavior or comfort was more likely to influence housing practices for those that housed calves socially (any form of social housing vs. individual housing only: 86 vs. 68% indicated that the decision to house calves according to current management was influenced by “calf comfort,” “opportunity for natural behavior,” or both; $P = 0.026$). This relationship was primarily driven by a difference in stated influence of providing “opportunity for natural behavior” in housing management (64 vs. 8%; any form of social housing vs. individual only; $P < 0.001$). There was no relationship between the use of social housing and stated importance of factors related to health (any form of social housing vs. individual only: 69 vs. 81% indicated that the decision to house calves according to current management was influenced by “management of disease,” “identification of sick calves,” and/or “effective treatment of sick calves”; $P = 0.28$). Similarly, the stated relevance of factors related to economics and labor did not differ between housing styles (any form of social housing vs. individual only: 82 vs. 70% indicated that the decision to house calves according to current management was influenced by “ease of management for staff,” “labor efficiency,” and/or “cost effectiveness”; $P = 0.15$). Nine respondents selected “other” and added commentary on other motivating factors, including that housing decisions were influenced by facility design, including working with available space and within the constraints of barn layout. Two respondents from farms currently utilizing both individual and small group housing described perceived benefits of individual housing during the first 2–3 weeks of life, to facilitate cleaning and individual feeding and disease monitoring, before moving calves to social groups. One respondent from a farm implementing only housing calves in groups of more than 8 calves entered “calf socialization and adaptability” as a factor motivating the decision to house calves according to current management.

**Perception of welfare implications of calf behavior and management**

Perceptions of how calf behaviors relate to calf health/performance and comfort is shown in Figure 2. Cross-sucking (Figure 2A) and pen-directed sucking (Figure 2B) were perceived as being associated with poor health and comfort, although this perception was worse for comfort than health (cross-sucking: $P < 0.001$; pen-directed sucking: $P = 0.022$). There was no difference in the perception of how cross-sucking affected welfare between those that reported commonly observing cross-sucking (55% of respondents) and those that did not ($P > 0.8$), and similarly no difference in the perception of how pen-directed sucking affected welfare between those that reported commonly observing it (23% of respondents) and those that did not ($P > 0.4$). Eating bedding (Figure 2C) was similarly perceived as being associated with worse health than comfort ($P = 0.039$), although both perceptions skewed toward negative. Those that did not commonly observe this behavior (47% of respondents) viewed it as worse for health/performance ($P = 0.027$) and numerically worse for comfort ($P = 0.070$) compared with respondents who observed eating bedding commonly. The distribution of responses did not differ between respondents who reported providing straw (or a combination of straw and “other”) for calves to rest on and those who provided sand, mats, no bedding, or only “other” (which may be assumed to include wood chips/shavings), for either health/performance ($P = 0.6$) or comfort ($P = 0.70$). Reported observations of eating bedding commonly did not differ significantly between respondents varying in provision of straw (60.4% vs. 43.8%; respondents from farms providing straw vs. sand or other combinations; $P = 0.17$).

Self-grooming (Figure 2D) was perceived as being associated with better health than comfort ($P = 0.034$). Those that commonly observed self-grooming (49% of respondents) considered it to be associated with better comfort ($P < 0.001$) compared with those that did not see it commonly, whereas perception of associations with health did not differ between those that observed it commonly and those that did not ($P = 0.17$). The
distribution of scores describing perceptions of how social play (Figure 2E) related to calf comfort did not differ from calf health/performance \((P = 0.93)\), but social play was perceived more positively for both comfort \((P = 0.019)\) and health \((P = 0.015)\) by those that commonly observed it (100% of respondents who indicated that social housing was implemented) compared with those that did not implement social housing. The distribution of scores describing perceptions of how social lying (Figure 2F) related to calf comfort did not differ from calf health/performance \((P = 0.57)\) and did not differ between those that observed it (100% of respondents who indicated that social housing was implemented) and those that did not implement social housing.

Perceptions of how aspects of calf management affect calf health/performance and comfort is shown in Figure 3. Perception of providing greater milk allowances (>8 qt or 7.6 L/d; Figure 3A) was favorable and perceived effects did not differ between health/performance and comfort \((P = 0.58)\). Respondents who reported their facilities feeding milk at this level or greater perceived it as more favorable for both comfort \((P = 0.039)\) and health \((P = 0.0054)\) than those that were feeding less milk. Social housing (Figure 3B) was also perceived positively, but this perception was more favorable for calf comfort than health/performance \((P = 0.0056)\). Respondents from farms that were implementing social housing perceived it as more favorable for comfort \((P < 0.001)\) and health \((P = 0.040)\) compared with respondents from farms that were not housing calves socially.

Perception of brush provision was positive for comfort (72% of respondents described it as “somewhat positive” or “positively” affecting calf comfort or behavior and 14% were neutral) and health (71% described it as “somewhat positive” or “positive” for calf health/performance and 19% were neutral), with no difference in response distributions between these aspects of welfare \((P = 0.99)\). Similarly, provision of objects for interaction/play (e.g., hanging balls) was perceived positively for comfort (67% described it as at least “somewhat positive” and 19% were neutral) and health (63% described it as at least “somewhat positive” and 28% were neutral), with no significant difference between response distributions \((P = 0.19)\).

Respondents were asked to indicate perceived preference of calves for different resources often considered to improve welfare or provide enrichment. Respondents had a fairly neutral perspective on whether calves preferred access to forage, but respondents from farms that provided forage to pre-weaned calves perceived it as a more highly preferred resource, compared with respondents from farms not providing forage (Figure 4A; \(P = 0.0098\)). Access to other calves was perceived as more preferred, but respondents from farms that housed calves socially perceived access to other calves as more important than those who use only individual housing (Figure 4B; \(P < 0.001\)). Respondents from farms that provided milk or milk replacer by a teat perceived a dummy teat as a more highly preferred resource by calves compared with respondents from farms that did not feed milk through a teat (Figure 4C; \(P = 0.039\)). There was no relationship between feeding milk through a teat and perception of preference for other objects to orally manipulate \((P = 0.12)\).
respondents, 14% indicated highly, 69% somewhat, and 19% not preferred). Respondents had a neutral view of calf preference for brushes, with 17% selecting that they were highly preferred, 65% that they were somewhat preferred, and 17% that they were not preferred by calves. Overall, respondents varied in their evalua-
tion of preference across this range of items: 43% of respondents selected each option (“highly,” “somewhat,” or “not” preferred) at least once, 45% of respondents selected only “highly” or “somewhat” preferred for all resources, 9% selected only “somewhat” or “not” preferred, and 3% selected only “somewhat” preferred.

Perception of the importance of “freedom from hunger and thirst” (considered “very important” by 92.9%, “somewhat important” by 3.5%, and “slightly important” by 3.5% of respondents), “freedom from pain and discomfort” (considered “very important” by 94.2%, “somewhat important” by 2.3%, and “slightly important” by 3.5 of respondents), and “freedom from injury and disease” (considered “very important” by 96.4% of respondents, “somewhat important,” and “slightly important” by 1.3% of respondents) did not differ between respondents from farms providing > or <7.6 L of milk per day (P > 0.25) or between farms using social or individual housing (P > 0.37). Respondents from farms currently using social housing considered “freedom to express natural behavior” to be more important, compared with respondents from farms not using social housing (75 vs. 53% selected “very important”; social housing used vs. no social housing used; P = 0.039; Figure 5A) and numerical trends suggested they may not differ between respondents from farms providing different milk levels (P > 0.3). Most respondents (63%) selected “very important” for all criteria in this question and 29% selected only either “very important” or “somewhat important” (the exception from “very important” was only for “freedom to express natural behavior” for 55% of respondents in this category).

Perception and practices related to the human-animal relationship

Agreement with statements related to aspects of human-animal relationship was compared between respondents who reported different standard procedures related to the frequency of calf handling, and between respondents who reported different personal habits related to interaction with calves. Respondents from farms where calves were routinely handled more than once per week (43% of respondents), compared with those who handled them less frequently, had greater agreement with the phrase “Dairy calves enjoy contact with the people who care for them” (Figure 6A; P = 0.015) and “Dairy calves are able to recognize the people who care for them” (Figure 6B; P = 0.0083). Respondents who reported “often” personally contacting calves to scratch or pet them (60%) also had greater agreement with both phrases (Figure 6C; P = 0.0070 and Figure 6D; P = 0.0078) than respondents who only reported personally contacting calves “sometimes,” “rarely,” or “never.” Greater agreement with both phrases was also seen for respondents who often talked to calves (77%
of respondents; \( P < 0.0085 \) and named calves (45% of respondents; \( P < 0.001 \)), compared with those who did not. Agreement with these phrases did not differ between farms with and without social housing (\( P > 0.48 \)). Similarly, the use of social housing on farm was not related to reported personal habits of interaction with calves (\( P > 0.58 \)).

Handling calves (response to the question “how difficult do you perceive handling dairy calves to be”?) was described as extremely difficult by 1%, of respondents somewhat difficult by 25%, neither easy nor difficult by 27%, somewhat easy by 40%, and extremely easy by 8%. This response distribution did not differ between farms where calves were handled more than once per week vs. less often (\( P = 0.47 \)) or between respondents who reported different personal habits describing frequency of calf-directed behaviors (including contacting calves to scratch or pet them, talking to calves, and naming calves; \( P > 0.27 \)). The use of social housing was also not related to perceived difficulty of handling calves (\( P = 0.44 \)).

Respondent demographics (gender, age, education, and role on farm) were not significant predictors of responses to questions about the human-animal relationship, including agreement with the phrases “Dairy calves enjoy contact with the people who care for them” (\( P > 0.64 \)), “Dairy calves are able to recognize the people who care for them” (\( P > 0.56 \)), or “Dairy calves enjoy contact with the people who care for them” (\( P > 0.87 \)). However, female respondents reported greater frequencies of contacting calves to scratch or pet them (female vs. male: estimate = 0.86; SE = 0.24; \( P < 0.001 \)), allowing calves to sniff them (female vs. male: estimate = 0.78; SE = 0.22; \( P < 0.001 \)), talking to calves (female vs. male: estimate = 0.71; SE = 0.17; \( P < 0.001 \)), and giving calves a name (female vs. male: estimate = 1.3; SE = 0.27; \( P < 0.001 \)), while controlling for age (\( P > 0.50 \)), education (\( P > 0.24 \)), and role on the farm (\( P > 0.34 \)).

Most respondents indicated a high degree of job satisfaction (50% strongly agree and 37% agree with the statement “I feel satisfied with my job”) and positive colleague relationships (36% strongly agreed and 46% agreed with “I get along with my coworkers”). The cumulative score generated from responses to questions about human-animal relationship (agreement with “Dairy calves enjoy contact with the people who care for them” and “Dairy calves are able to recognize the people who care for them”) was positively correlated with the cumulative score for these 2 questions related to job satisfaction and workplace environment (Spearman correlation coefficient = 0.24; \( P = 0.027 \)). Respondent response to questions about job satisfaction did not differ between farms that socially housed calves and those that did not (\( P = 0.81 \)).
Resources to improve calf care

The majority of respondents (81%) indicated that they would be interested in educational resources on promoting healthy calf behavior or practicing good calf handling. Open text responses were provided by 41 respondents, describing information they would be most interested in receiving to help refine calf care. Many respondents (42%) indicated an interest in resources related to aspects of calf housing or management in general. Of these responses, 30% specifically noted an interest in resources related to social housing. Others mentioned an interest in resources to support improved calf comfort and housing design. Health was also a concern for many respondents, with 32% indicating an interest in resources to improve calf health, with some specific comments referring to disease and scours prevention and disease treatment. An interest in resources related to nutrition was mentioned by 24% of respondents, with specific topics of interest including weaning and benefits of increased milk intake. Some respondents (17%) indicated a specific interest in topics related to calf behavior, with some referring to cross-sucking specifically, and others indicating a general interest in calf behavior, including benefits of providing enrichments. Seventeen percent of respondents specifically noted an interest in accessing new information/ideas and current research.

When asked who they would feel most comfortable receiving information from, 91% selected veterinarians, 69% selected researchers/animal behaviorists, 49% selected extension agents, and 42% selected business leaders in the agriculture industry. Five percent of respondents selected “other,” with responses mentioning a preference in receiving information from a variety of sources including other progressive producers, credible sources on social media, and experts in new technologies (e.g., artificial intelligence).

DISCUSSION

Commercially raised dairy calves are subject to variable management and environmental factors on-farm, which have implications for both behavior and welfare. In this survey, we were interested in US producer habits and perceptions of how management factors are related to aspects of calf behavior and welfare. We first assessed how respondents perceived the relationship between various calf behaviors and aspects of welfare. We found that perception of how behaviors were related to calf comfort and to health/performance were generally aligned, although the strength of opinion differed between some behaviors. We additionally focused on welfare considerations related to social housing and milk-feeding level, practices which are currently somewhat divisive and varied in the dairy industry (Roche et al., 2023). We were additionally interested in gaining insight into producer concern for the subjective well-being of dairy calves. We addressed this using the term “calf comfort,” rather than “affective state,” which is common only in scientific literature, or “emotional state,” which we thought may be interpreted as too anthropomorphic for many respondents. While the term “cow comfort” is commonly used in producer discussions of animal welfare issues (Ventura et al., 2015), a limitation is that this may be viewed broadly or differently by

Figure 5. Histograms showing distribution of perceived importance of different aspects of welfare (“How important do you consider these factors to be for calves,” with options of “not important,” “slightly important,” “somewhat important,” and “very important”) for A) freedom to express natural behavior, and B) freedom from fear and distress.
different respondents. However, in a recent survey, producers described “calf comfort” as a motivating factor in the use of pain control for calves, suggesting that this term may resonate as a proxy for emotional experiences such as pain (Saraceni et al., 2022). Overall, we found that, as predicted, approaches to managing calves were widely variable. We also found that perceptions of how a practice or behavior related to calf health sometimes differed from how it related to calf behavior, and that these perceptions also depended on on-farm practices reported by the respondent.

We first evaluated respondent perception of how behavioral expression relates to calf welfare. Respondents had positive views of how social behaviors, including social play and social lying, relate to comfort and health. This aligns with an abundance of recent research supporting welfare benefits of opportunities for social behavior, as well as evidence that social play is reduced when animals are experiencing negative states like pain (Mintline et al., 2013). We also found that respondents from farms implementing social housing had a more favorable perception of social play and were also more likely to perceive that calves “often” interacted with other calves. Effects of observing behavior on perceived importance of that behavior may be attributed to an availability bias (i.e., out of sight, out of mind), where we tend to ignore the importance of missing information (Korteling et al., 2018). We found that respondents had variable perceptions of the association between self-grooming and comfort, which aligns with uncertainty in the scientific literature over how the performance of self-grooming relates to housing conditions (reviewed by Napolitano et al., 2009). Interestingly, the skew of this response was more positive for respondents who reported commonly observing the behavior, and negative for those who did not, sug-
gesting that some bias may shape assumptions about a behavior, in the absence of definitive information. However, self-grooming was perceived as being more strongly associated with good health, compared with comfort, perhaps due to consideration of possible benefits for cleanliness (Horvath and Miller-Cushon, 2019a) or noted reductions in self-grooming when calves are sick (Borderas et al., 2008; Hixson et al., 2018).

We found that respondents had negative perceptions of behaviors commonly categorized as abnormal oral behaviors (pen-directed sucking, eating bedding, cross-sucking), although these perceptions were stronger for cross-sucking, and pen-directed sucking and eating bedding were perceived more ambiguously. Some ambiguity may be due to interpretation of the question; for example, pen-directed sucking could be perceived as being associated with relatively poor comfort by respondents who attribute it to frustrated sucking motivation (aligning with research findings; Horvath and Miller-Cushon, 2017), but good comfort, by respondents who agree that sucking is important but consider pen-directed sucking to be an adequate substitute for this behavioral motivation (perhaps akin to non-nutritive sucking on a dummy teat; de Passillé et al., 1993). We found that perception of cross-sucking and pen-directed sucking did not relate to how commonly respondents observed these behaviors. In general, respondents did not perceive that calves highly prefer access to a dummy teat or other objects for oral manipulation, which can reduce abnormal oral behavior (Salter et al., 2021). However, respondents from farms that provided milk by a teat were less likely to view that access to a dummy teat was “not preferred,” perhaps reflecting a greater awareness of sucking motivation. While providing milk by a teat was commonly reported (75% of respondents), a third of these also reported the use of buckets at some point during the pre-weaning period, suggesting that calves may be initially provided milk by teat but then transitioned to drinking from a bucket. This transition from teats to buckets was described as a common practice in the most recent national survey (USDA-APHIS, 2014). However, the total percentage of respondents describing bucket feeding at any point in the pre-weaning period in the present study is lower than reported previously (48% respondents in this study vs. 72% farms reported bucket feeding; USDA-APHIS, 2014). In future surveys, it would be meaningful to clarify the time frame of different milk-feeding methods to better understand producer practices and perceptions with respect to milk-feeding method and the performance abnormal oral behaviors. Interestingly, eating bedding was perceived as less problematic by respondents who reported seeing it commonly. Both frequency of ingesting bedding and perceived health effects may logically depend on the type of bedding used (e.g., sand impaction is an issue with sand bedding; Melendez et al., 2007). However, we found no significant difference in perception of the relationship between eating bedding and either health/performance or calf comfort between respondents providing straw and other bedding types. Relationships between management strategies and observed frequencies of understudied and potentially problematic behaviors such as eating bedding are worth targeting in future experimental work.

Performance of abnormal behaviors in calves is related to environmental complexity in general, beyond milk feeding level and method. We found that perception of providing resources with potential enrichment value (brushes, or other objects for interaction/play) were almost universally perceived as positive for both comfort and health yet were provided by < 6% of farms. However, questions about how calves prefer these resources were less definitive, with the majority of respondents having a neutral view as them being “somewhat” (vs. “highly” or “not”) preferred. While literature supporting the benefit of some objects intended for play is lacking, there is clearer evidence that calves use brushes (either stationary or rotating) and they can provide some benefits, including increased cleanliness (Horvath and Miller-Cushon, 2019a) and reduced pen-directed sucking (Horvath et al., 2020). In contrast to minimal provision of other enrichment items, respondents indicated that hay or other forage was provided on nearly half of the farms. Providing forage to pre-weaned calves has historically been discouraged from a nutritional standpoint, yet more recent research supports a range of benefits of hay provision for reducing abnormal oral behaviors (Horvath and Miller-Cushon, 2019b; Downey and Tucker, 2023; Castells et al., 2012) and increasing total solid feed intake and stimulating rumination and rumen development (Castells et al., 2012; Khan et al., 2011b). There is a lack of recent data describing current on-farm practices describing on-farm provision of hay to young calves. Interestingly, the 2011 NAHMS survey of operations raising dairy heifers (USDA-APHIS, 2011) reported that smaller operations (<100 heifers) provided hay or other roughage to calves around an average of 3 weeks of age, whereas larger farms provided hay on average just after weaning. Although we did not collect data regarding age of forage provision in the present survey, our data described the same trend, where respondents reported declining provision of forage for pre-weaned calves as farm size increased. Hay was more likely to be perceived as a highly preferred resource by respondents on farms providing hay. These findings suggest an avenue for future extension efforts, which is also suggested by respondents’ stated interest
in resources related to enrichment and reducing abnormal oral behavior.

A main focus of this survey was perception of greater milk feeding levels and social housing, practices which are considered beneficial for calf welfare (reviewed by Costa et al., 2019). While recent widespread survey data are lacking, evidence suggests that adoption of these practices has been mixed (reviewed by Roche et al., 2023). Approximately 70% of producers persisted in housing calves individually and feeding less than 8 L/d of milk according to the most recent national US survey (USDA-APHIS, 2014), although calf age was not specified in that survey which likely resulted in mixed interpretation and reporting. In contrast, we found that close to 60% of respondents in this survey were providing calves over 7.6 L/d of milk at 4 weeks of age and housing calves in social groups for at least part of the pre-weaning period. However, it is concerning to note that 5% of respondents described housing calves without even visual contact between animals, which is contrary to expectations of the Farmers Assuring Responsible Management (FARM) program (FARM, 2020). Our results regarding milk feeding level align with Canadian survey data, where average milk allowances are close to 8 L/d (Winder et al., 2018). In the absence of recent national data, it is hard to say how representative this is. This survey is based on a convenience sample which may not be representative of US producers in terms of geography and herd size. Our responses were primarily from the Eastern US and skewed toward large farms (39% of respondents reported >500 heifer calves born per year, vs. 26% of farms in the Eastern US housed >500 cows, according to 2014 NAHMS calf component survey responses; USDA-APHIS, 2014). Given the focus of this survey, it is also possible that respondents are over-representative of producers and managers who personally prioritize animal welfare and, correspondingly, have an above-average likelihood of supporting adoption of these practices.

We had predicted that social housing may be perceived as causing a conflict between health and comfort, yet while social housing was perceived as better for health, both distributions skewed toward positive. This may suggest that many producers are aware of research findings that social housing does not consistently negatively affect health (reviewed by Costa et al., 2016). Those respondents from farms that were currently housing calves socially weighed consideration of calf natural behavior or comfort as a more influential factor in their housing decisions than those housing calves individually, and were also more likely to describe “freedom to express natural behavior” as being very important and tended to consider “freedom from fear and discomfort” as very important. These results may be interpreted as a general alignment between implementation of social housing and increased concern for a calf’s subjective well-being. Our findings also suggest that many producers are aware of benefits of providing calves more milk (reviewed by Khan et al., 2011a), and perception of the importance of various aspects of welfare (such as the “Five Freedoms”) did not differ between respondents providing different levels of milk. These findings suggest that barriers to increasing milk feeding level are related in part to factors other than perceived welfare benefits (e.g., cost or labor; discussed by Roche et al., 2023), which could be explored in future work.

We found that respondents perceived both social housing and feeding >7.6 L/d of milk as being associated with better welfare when their farm of employment was currently implementing these practices, suggesting an influence of either personal bias or experience. This may be explained in part by the high percentage of respondents who may be assumed to be decision makers on-farm (i.e., owners and managers), as those people with existing perceptions that a certain practice is good for health or comfort may have been more likely to already implement it. However, our results may also suggest that experience with certain practices that are arguably good for welfare, such as providing more milk or socially housing calves, improves perception of that practice. This relationship between practical experience and perceptions would seem to align with behavioral changes reflecting improved welfare in calves housed socially (e.g., reducing fearfulness; Meagher et al., 2015) and provided more milk (e.g., reducing hunger; De Paula Vieira et al., 2008) observed in research trials. This finding may support the efficacy of peer-to-peer learning as a valuable tool and potential motivator of change as producers consider management challenges (Wilson et al., 2021; Roche et al., 2019).

We found that respondents’ perception of a positive human-animal bond (i.e., that calves enjoy contact with humans) was positively related to both individual respondents’ reported frequency of personal calf interaction and indicated standard farm procedures for calf contact. As with perception of housing practices, it is unclear whether this relationship may be due to pre-conceived views driving implementation of practices, or experience with practices shaping perceptions. Previous studies have also found that human attitudes are related to aspects of the human animal relationship and behavior in adult cows (Waiblinger et al., 2002; Hems-worth et al., 2000). While respondent demographics were not predictive of the perceptions of the human-animal relationship, we found that female respondents described a greater frequency of positive interactions.
with calves. This aligns with previous studies where women have described more positive interactions (petting, talking) with veal calves (Lensink et al., 2000) and cows have been found to be less avoidant on farms where the main milker is a woman (des Roches et al., 2016). We had predicted that aspects of the human-animal relationship may be related to the use of social housing, but we found no differences in perceptions of the human-animal relationship, attitudes toward calf handling, or personal habits related to calf interaction between respondents from farms differing in the use of social housing. In experimental studies, some evidence suggests that individually housed calves may be less avoidant of humans (Doyle et al., 2022; Duve et al., 2012), without any effects on ease of handling (Mogensen et al., 1999). The results from this observational survey suggest no clear differences in the nature of human-animal interaction between farms differing in provision of social housing. Finally, our results also suggested a correlation between job satisfaction and perception of human-animal interaction in personnel working with calves, a finding which is consistent with work in adult cows (des Roches et al., 2016).

CONCLUSIONS

This survey provides insight into how US producers and managers perceive the relationship between behavior, management, and welfare, in commercially raised dairy calves. We found generally positive perceptions of practices which, based on animal research, are considered to improve calf welfare, including social housing and increased milk allowance. Perceptions differed between respondents who reported commonly observing certain calf behaviors and implementing practices in question, and the mechanism of these effects might be explored in future work. Respondents from farms using social housing, compared with those using only individual housing, perceived opportunity for natural behavior as more important for calves and placed a higher value on social behavior. Aspects of the human-animal relationship were not related to calf management but were related to respondents’ self-reported behavior toward calves and their job satisfaction. Respondents viewed abnormal oral behavior as problematic for calf welfare, but responses suggest a lack of clarity in approaches to accommodate behavioral needs and mitigate abnormal behaviors. Future research and extension efforts may draw on these findings toward refining calf management and improving animal welfare.

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