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Alzheimer's disease development in adults with Down syndrome: Caregivers' perspectives

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Abstract

Research about Alzheimer's disease (AD) in individuals with Down syndrome (DS) has predominantly focused on the underlying genetics and neuropathology. Few studies have addressed how AD risk impacts caregivers of adults with DS. This study aimed to explore the perceived impact of AD development in adults with DS on caregivers by assessing caregiver knowledge, concerns, effect on personal life, and resource utilization via a 40-question (maximum) online survey. Survey distribution by four DS organizations and two DS clinics resulted in 89 caregiver respondents. Only 28 caregivers correctly answered all three AD knowledge questions. Caregivers gave an average AD concern rating of 5.30 (moderately concerned) and an average impact of possible diagnosis rating of 6.28 (very strong impact), which had a significant negative correlation with the age of the adult with DS (p = .009). Only 33% of caregivers reported utilization of resources to gain more information about the AD and DS association, with low levels of perceived usefulness. Our data reveal caregivers' misconceptions about AD development in DS, underutilization of available resources, and substantial concerns and perceived impacts surrounding a possible AD diagnosis. This study lays the foundation for how the medical community can better serve caregivers of aging adults with DS.

KEYWORDS

Alzheimer's disease, caregivers, down syndrome

1 | INTRODUCTION

The complex medical issues of individuals with Down syndrome (DS) are well-defined and have been a prominent focus of medical research. Due to medical and societal advancements, people with DS are now living to later ages, with the average life expectancy reaching 53 years (mean) and 58 years (median) in 2010, as opposed to 26 years (mean) and 4 years (median) in 1950 (de Graaf, Buckley, & Skotko, 2017). These longer lifespans have left researchers with the task of elucidating the many intricacies of aging in DS.

Data suggest that adults with DS experience accelerated and atypical aging when compared to the general population, causing individuals with DS to experience age-related health issues at earlier stages in life (Zigman & Lott, 2007). One of these health issues is the potential development of Alzheimer's disease (AD; Moran, Hogan, Srsic-Stoehr, Service, & Rowlett, 2013; Zigman & Lott, 2007).

AD, the most common form of dementia, is characterized by devastating effects on memory, personality, behavior, and thinking capacity (Alzheimer's Association, 2018). The amyloid precursor protein (*APP*) gene has been found to have a causational association with AD and is located on the proximal portion of the long arm of chromosome 21, which is triplicated in most people with DS (Zigman, 2013; Zigman & Lott, 2007). Its gene product, amyloid β protein (Aβ), can lead to the formation of neuritic plaques (Aβ plaques) in the cerebral cortex when present in excess (Zigman & Lott, 2007). The downstream effects of this Aβ deposition are believed to be neurofibrillary

tangles, neuronal cell death, brain atrophy, vessel impairment, and the subsequent onset of dementia (Zigman, 2013). Due to the location of the *APP* gene on chromosome 21, overexpression of this gene occurs in individuals with DS, resulting in surplus production and accumulation of Aβ protein known to cause the characteristic plaques seen in AD (Zigman, 2013; Zigman & Lott, 2007). It has been shown through autopsy studies that almost all adults with DS exhibit classic AD neuropathology by 35–40 years of age, which is 20–30 years earlier than the general population (Dekker et al., 2015; Zigman, 2013; Zigman & Lott, 2007). However, this neuropathology has been shown to predate onset of AD symptoms by approximately 10 years, with some individuals with DS never showing AD symptoms (Zigman & Lott, 2007).

In contrast to the general population, the first noticeable clinical signs of AD development in individuals with DS are changes in personality and behavior (Ball et al., 2006; Carr & Collins, 2014). These behavioral changes, which are claimed to take precedence over neurological changes (e.g., memory loss), include apathy, depression, aggression, restlessness, social withdrawal, and stubbornness (Ball et al., 2006; Carr & Collins, 2014). However, independent of AD, the extensive list of health concerns associated with DS can cause changes in behavior or personality as a result of symptom manifestation or a reaction to treatment (Steingass, Chicoine, McGuire, & Roizen, 2011). Being able to distinguish these behavioral and personality changes from the changes associated with AD is important since many of these other mimicking medical and psychiatric conditions can be treated (Brotman, 2014). Also difficult to distinguish is the cognitive decline related to AD from the intellectual disability and age-related decline present in adults with DS (Menéndez, 2005). Overall, it is clear that a considerable overlap exists between the clinical presentations of AD and DS. Due to this overlap, it has been found that symptoms of DS tend to overshadow symptoms of AD, delaying a diagnosis and early intervention methods (Brotman, 2014).

The medical literature extensively reports profound burden on caregivers of individuals with AD, in general (Sansoni, Anderson, Varona, & Varela, 2013). The stress, depression, and social isolation that may be associated with caregiving in the AD setting is well-noted, as are the associated influencing factors, such as resource availability and care responsibilities (D'Onofrio et al., 2015; Sansoni et al., 2013). In the setting of caregiving and DS only, things like behavior problems, lower level of daily functioning, lack of community participation, and life transitions have been recognized as sources of caregiver stress (Bourke et al., 2008; van der Veek, Kraaij, & Garnefski, 2009). However, some caregivers also report positive caregiving experiences, such as lessons in patience, acceptance, and flexibility (Skotko, Levine, & Goldstein, 2011).

Although valuable caregiving data exist about both DS and AD as two separate entities, there is a noted information gap present in the research pertaining to awareness, management, and resources available for caregivers who manage a codiagnosis of DS and AD (Carling-Jenkins, Torr, Iacono, & Bigby, 2012). In fact, a general unawareness of the increased risk of AD development in adults with DS among family caregivers and service providers has also been documented (Carling-Jenkins et al., 2012). Adequate resource knowledge and utilization, as well as proactive planning for the future has proved to be incredibly important in developmental disability populations that may also face a diagnosis of AD (Heller & Caldwell, 2006). Appropriate planning can help to avoid urgent decision-making in the face of a diagnosis or change in caregiver health and ability status (Heller & Caldwell, 2006). As medical advancements continue to take place and the lifespans of individuals with DS continue to extend, AD will undoubtedly become an increasingly prominent concern for this community. The information available to the medical community about this specific niche of caregiving is lacking; this study aimed to address this information gap by delineating the psychosocial complexities, needs, and knowledge base of this specific caregiver population.

2 | METHODS

2.1 | Participants

This cross-sectional study recruited individuals, 18 years of age or older, who were the primary caregivers (e.g., parent, guardian, sibling) for an adult with DS, also 18 years of age or older. Caregivers were recruited from four Ohio-based DS nonprofit organizations, one adult DS specialty clinic in Ohio, and one adult DS specialty clinic in Illinois. This research was approved by the Institutional Review Board of The Ohio State University.

2.2 | Instrumentation

The anonymous and voluntary survey was developed and distributed through SurveyMonkey. Respondents answered a maximum of 40 questions distributed over three main sections. Branching logic was utilized to avoid inappropriate or redundant questioning; therefore, with the utilization of branching logic, the total number of questions varied depending on how a participant answered specific questions.

The first two sections of the survey gathered demographic information about respondents as well as the adult for whom they care. Information about the adult with DS's overall health was gathered, and participants were asked if the adult with DS had a concurrent diagnosis of AD. This portion of the survey also sought to establish a functional activity score (FAS) for the adult with DS by utilizing a previously published activities scale (Skotko et al., 2011). This scale asked caregivers to report their opinion on how well the adult with DS could perform 11 activities on a 7-point Likert scale (from 1 [not at all] to 7 [very well]).

The third section of the survey explored caregiver knowledge about AD and DS using multiple choice questions, which allowed for the determination of an overall caregiver knowledge score (0–3) derived from the number of questions answered correctly. One 7-point Likert scale (strongly disagree to strongly agree) also asked caregivers to rate their confidence in distinguishing symptoms of AD

from symptoms of DS. Overall caregiver concern and impact ratings were assessed using 7-point Likert scales (not at all concerned/no impact to extremely concerned/extremely strong impact). Similar Likert scales were used to explore 12 possible concerns surrounding an AD diagnosis in the adult with DS and 12 possible ways that a diagnosis of AD in the adult with DS could impact the life of the caregiver. Caregiver resource utilization was also explored using 7-point Likert scales that asked caregivers to rate the usefulness of each specific resource (not at all useful to extremely useful) utilized. Those caregivers who had not yet utilized resources were asked to specify the resources they would be most willing to use and find useful. Using a 7-point Likert scale (extremely dissatisfied to extremely satisfied), caregivers were also asked to rate their satisfaction with discussions about AD and DS with a healthcare provider, if such a discussion has taken place. Text boxes accompanied most survey questions to allow caregivers space to expound upon their choices and supply any additional information they deemed necessary.

2.3 | Data analysis

Descriptive statistics were used to characterize demographics of both the caregivers and the adults with DS in the study population. Unlike the previously published study using FAS that focused on the distribution of FAS among the adults (Skotko et al., 2011), this study focused on how age specifically affected these scores. Therefore, the total sum of the caregiver ratings was divided by the total number of activities to create a FAS for each adult with DS. Formulating the scores this way allowed for consistency when comparing age cohorts of the adult with DS with FAS and the additional variables in the study. Descriptive statistics (proportions) were also used to characterize caregiver resource utilization.

The proportion of individuals who could correctly answer each factual question was calculated. In order to create caregiver knowledge scores, the sum of the number of correct responses was utilized. A chi-square test was then used to assess the association between caregiver knowledge score and caregiver confidence in distinguishing the symptoms of DS from the symptoms of AD.

Means of Likert scale items were calculated to facilitate comparisons between items when necessary. Analogous analyses were performed using the Likert scale items for 12 specific concern and impact topics. Associations between the caregiver concern and impact Likert scale scores and continuous variables (age of adult with DS, FAS, and number of health problems) were assessed via Pearson correlation. A p value of <.05 indicated a significant correlation for all association studies. All data analysis was performed in Stata version 13 (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP).

3 | RESULTS

3.1 | Study participant characteristics

A total of 106 caregivers began the survey for this study. Given the membership population of the four DS advocacy groups and the two DS clinics, it was estimated that the study survey reached approximately 1,000 individuals. However, it is difficult to estimate what percentage of these individuals fell into the study eligibility criteria. One participant reported that their adult with DS was 17 years of age so they were excluded from analysis. An additional five participants were excluded

TABLE 1 Caregiver demographic data

Caregiver demographic characteristics	*n*	%
Relationship to adult with DS (N = 89)		
Parent	78	87.6
Sister/brother	10	11.2
Other ("guardian")	1	1.1
Age of caregiver (N = 88)		
Mean = 58.2 years		
Median = 58.5 years		
Range = 27–82 years		
SD = 9.6 years		
Gender (N = 89)		
Female	80	89.9
Male	9	10.1
Marital status (N = 89)		
Married	65	73.0
Separated/divorced	9	10.1
Widowed	9	10.1
Single	6	6.7
Hispanic/Latino (N = 89)		
No	87	97.8
Yes	2	2.3
Race (N = 88)		
Caucasian	85	96.6
Black/African American	1	1.1
American Indian/Alaska native	1	1.1
Other	1	1.1
Household income (N = 76)		
<$25,000	5	6.6
$25,000–$34,999	6	7.9
$35,000–$49,999	12	15.8
$50,000–$74,999	14	18.4
$75,000–$99,999	9	11.8
$100,000–$149,999	16	21.1
$150,000 or more	14	18.4
Education (N = 88)		
High school graduate (equivalent)	8	9.1
Some college (no degree)	19	21.6
Associate degree	15	17.1
Bachelor's degree	23	26.1
Some postgraduate (no degree)	4	4.6
Graduate/professional degree (other than PhD)	15	17.1
PhD	4	4.6

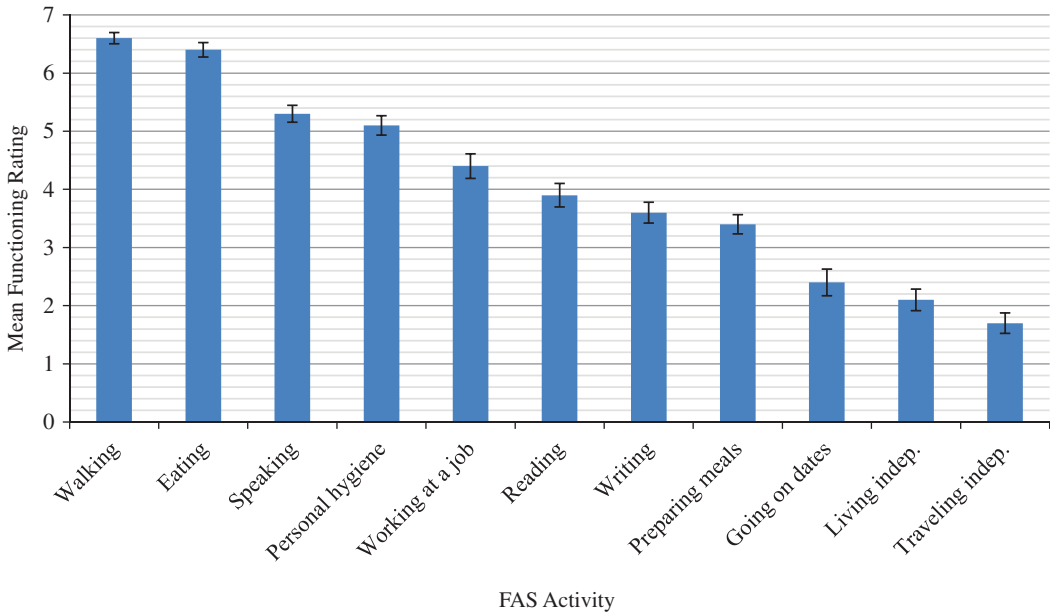

FIGURE 1 Mean functioning rating with *SE* for 11 activities included in functional activity score (1: not at all; 7: very well) [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 2 Caregiver responses to current medical problems for the adult with Down syndrome

Medical problem	*n*	Yes *n* (%)	No *n* (%)	I don't know *n* (%)
Eye/vision problems	87	72 (82.8)	15 (17.2)	0 (0.0)
Skin problems	87	48 (55.2)	39 (44.8)	0 (0.0)
Overweight/obesity	86	45 (52.3)	40 (46.5)	1 (1.2)
Thyroid problems	88	44 (50.0)	44 (50.0)	0 (0.0)
Hearing loss	84	25 (29.8)	59 (70.2)	0 (0.0)
Heart defect	86	23 (26.7)	63 (73.3)	0 (0.0)
High cholesterol	86	15 (17.4)	70 (81.4)	1 (1.2)
Psychiatric disease	86	15 (17.4)	68 (79.1)	3 (3.5)
Celiac disease	85	12 (14.1)	73 (85.9)	0 (0.0)
Neurological disease	83	9 (10.8)	72 (86.8)	2 (2.4)
Autism	86	8 (9.3)	77 (89.5)	1 (1.2)
Osteopenia/osteoporosis	83	7 (8.4)	74 (89.2)	2 (2.4)
Diabetes	85	6 (7.1)	79 (92.9)	0 (0.0)
Eating disorder	85	5 (5.9)	78 (91.8)	2 (2.4)
High blood pressure	86	0 (0.0)	85 (98.8)	1 (1.2)

Note: Caregivers were not required to leave a response for each medical problem; therefore, the total responses for each problem vary.

from data analysis for not completing the survey questions directly related to the main aims of the study. This resulted in a final cohort of 100 eligible caregiver participants. Out of these, 89 were caring for an adult with DS only, and 11 were caring for an adult with a dual diagnosis of DS and AD. Due to the small cohort size, the 11 caregivers of adults with a dual diagnosis (DS and AD) were excluded from the data analysis. The following results pertain only to the 89 caregivers for an adult with DS only.

TABLE 3 Caregiver knowledge questions

Knowledge question	*n*	%
(1) Are individuals with DS at an increased risk for developing AD?		
Correct ("yes")	81	91.0
Incorrect	8	9.0
(2) Will all individuals with DS develop AD in their lifetime?		
Correct ("no")	57	64.0
Incorrect	32	36.0
(3) What is the most common first symptom of AD in an adult with DS?		
Correct ("changes in behavior and/or personality")	43	48.3
Incorrect	46	51.7
"Confusion" (*n* = 21; 45.7%)		
"Memory loss" (*n* = 11; 23.9%)		
"I don't know" (*n* = 14; 30.4%)		

Abbreviations: AD, Alzheimer's disease; DS, Down syndrome.

The majority of caregivers who responded to the survey were parents of an adult with DS (*n* = 78; 87.6%) followed by siblings (*n* = 10; 11.2%). The average age of the caregiver responding to the survey was 58.2 years (range: 27–82 years; *n* = 88, *SD* = 9.6). Caregivers were predominantly female (*n* = 80; 89.9%), Caucasian (*n* = 85; 96.6%), and married (*n* = 65; 73.0%). The remaining caregiver demographic information can be seen in Table 1.

The mean age for the adults with DS was 31.5 years (range: 18–63 years; *n* = 84; *SD* = 11.3) and 55.7% (*n* = 49) were male. The vast majority were Caucasian (*n* = 82; 94.3%) and non-Hispanic/Latino (*n* = 82; 93.2%).

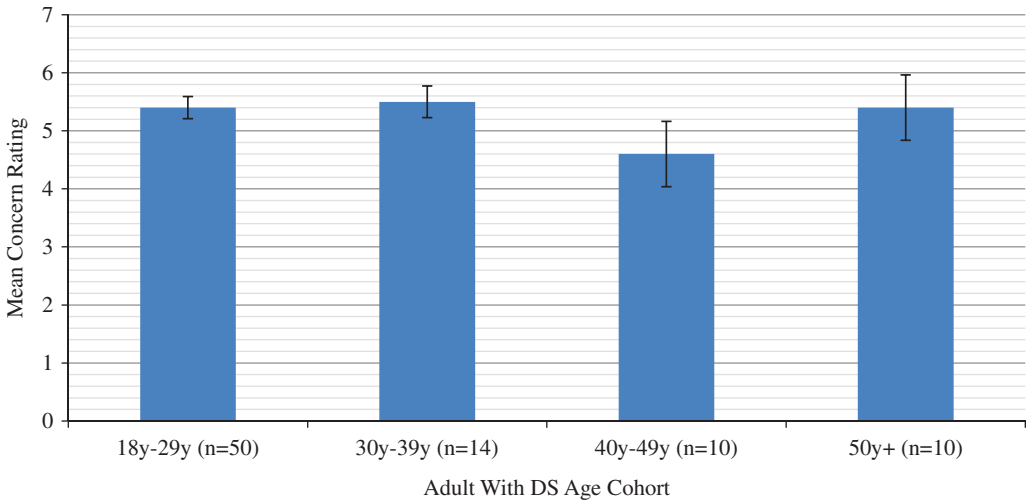

FIGURE 2 Mean caregiver concern rating with *SE* from each adult with Down syndrome age cohort [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 4 Mean caregiver concern rating from 1—"not at all concerned" to 7—"extremely concerned" for 12 specific concern topics

Specific concern	Mean concern rating (95% CI)	*n*
Quality of life for the adult	6.30 (6.08–6.53)	89
Behavior changes in adult	6.07 (5.82–6.31)	89
Change in adult's day-to-day functioning	6.05 (5.81–6.29)	88
Being able to adequately care for adult	5.98 (5.68–6.27)	89
Future health issues for adult	5.97 (5.69–6.24)	89
Change in adult's memory	5.93 (5.68–6.19)	89
Change in adult's living arrangements	5.91 (5.61–6.21)	88
Having a proper support system	5.87 (5.56–6.17)	89
Finding proper medical care, assistance, and resources	5.82 (5.51–6.13)	89
Adult being a danger to his or her own self	5.80 (5.48–6.11)	89
Change in adult's independence	5.74 (5.44–6.04)	89
Navigating medical, insurance, and legal systems	5.54 (5.20–5.89)	87

The mean FAS for the adults with DS, as rated by their caregiver, was 4.18 (n = 89; *SD*: 1.1). The mean functioning score for each of the 11 activities included in the FAS can be seen in Figure 1. For each 10-year increase in age, average FAS decreased by 0.20 points (95% confidence interval [CI]: [−0.46, 0.05]). This association was not statistically significant (p = .12).

Caregiver responses about the health status of the adult with DS can be seen in Table 2. On average, the adults with DS had 3.8 medical problems out of the 15 total problems queried (n = 89; *SD* = 1.6). For each 10-year increase in age, the average number of medical concerns increased by 0.3 (95% CI: [0.03, 0.63]). This association was statistically significant at the 0.05 level (p = .03).

3.2 | Caregiver knowledge about AD development in adults with DS

Three knowledge questions were asked of caregivers (Table 3). A knowledge score, or total number of correctly answered knowledge questions, was calculated for each caregiver. A total of 31.5% (n = 28) of caregivers correctly answered all three knowledge questions for a knowledge score of 3, followed by 42.7% (n = 38) receiving a score of 2. There were 23.6% (n = 21) receiving a score of 1 and 2.3% (n = 2) receiving a score of 0. On average, caregivers were able to answer two (95% CI [1.86, 2.20]) of the three knowledge questions correctly.

To further gauge their understanding of AD in adults with DS, these caregivers were asked to rate the level to which they agreed with the following statement: "I feel very confident in my ability to distinguish the symptoms of DS from the symptoms of AD," using a 7-point Likert scale. Out of the 89 caregivers, only about 30% (n = 26) were able to agree (n = 19; 21.4%) or strongly agree (n = 7; 7.9%) with the above statement, while the remaining 70.8% (n = 63) caregivers did not feel as confident in their abilities to distinguish the symptoms and gave ratings ranging from "strongly disagree" to "somewhat agree." On average, caregivers gave an agreement rating of 4.53, which falls between the "neither agree nor disagree" and "somewhat agree" responses. The caregiver's overall knowledge score was not associated with their confidence in their ability to distinguish the symptoms of DS from the symptoms of AD (p = .39).

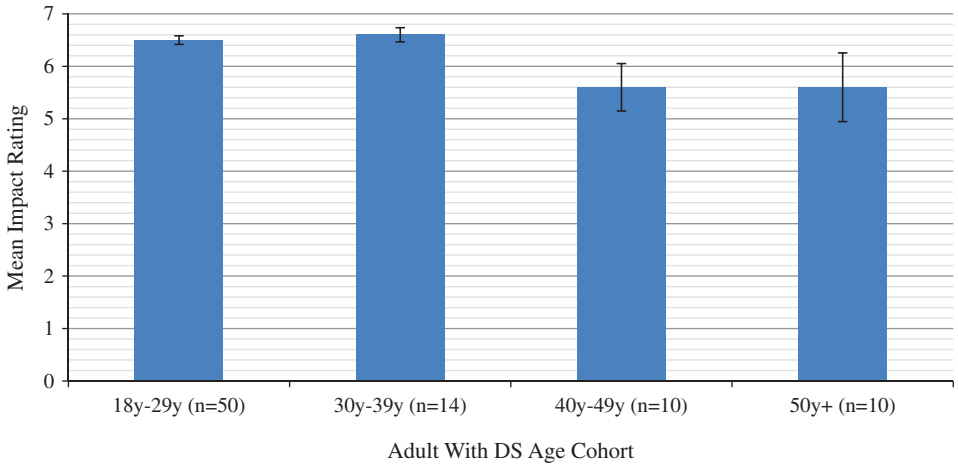

FIGURE 3 Mean caregiver impact rating with *SE* for each adult with Down syndrome age cohort [Color figure can be viewed at wileyonlinelibrary.com]

3.3 | Caregiver concern about AD development

Approximately 50% of caregivers (n = 46) expressed that they were "Very concerned/extremely concerned" about the possibility of an AD diagnosis in their adult with DS. Caregivers gave an average concern score of 5.30, which equates to a "moderately concerned" rating.

The age of the adult with DS did not significantly correlate to caregiver concern levels (r = −.09; 95% CI: [−.34, 0.17]; p = .51; Figure 2). However, those individuals caring for an adult with DS who was between 40 and 49 years of age had the lowest mean concern rating of 4.60. Generally speaking, it was found that the caregiver concern rating increased as the FAS of the adult with DS decreased, however this was not statistically significant (r = −.16; 95% CI: [−0.47, 0.15]; p = .30). Additionally, although not statistically significant, caregiver concern ratings increased as the number of medical concerns for the adult with DS also increased (r = .15; 95% CI: [−0.02, 0.33]; p = .08).

Table 4 lists the mean caregiver concern ratings for 12 topics regarding the development of AD in an adult with DS from highest concern to lowest concern. The concern for the quality of life for the adult with DS had the highest mean concern rating of 6.30, while the lowest mean concern rating of 5.54 was given to concerns about navigating medical, insurance, and legal systems.

3.4 | How a diagnosis of AD would impact the life of caregivers

A total of 80 (89.9%) caregivers believed that an AD diagnosis would have an "extremely strong impact/very strong impact" on their lives as caregivers. The remaining nine (10.1%) caregivers gave impact ratings of "no impact" (n = 1), "slight impact" (n = 3), and "moderate impact" (n = 5). This resulted in an average impact rating of 6.28, or a rating of "very strong impact."

The age of the adult with DS significantly correlated to caregiver perceived impact rating, (r = −.37; 95% CI: [−0.65, −0.09]; p = .009). This correlation showed that the caregiver impact ratings increased as the age of the adult with DS decreased (Figure 3). In general, the perceived caregiver impact increased as adult FAS's decreased. This observation is not statistically significant, largely due to the majority of caregivers giving impact ratings of 6 or 7, leaving very few observations for the lower impact ratings (r = −.02; 95% CI: [−0.37, 0.32]; p = .89). The same is true for the number of medical concerns the adult with DS had and caregiver impact rating. It appears as though caregiver perceived impact increased as the number of medical concerns also increased; however, the distribution of observations did not make for a significant correlation (r = .10; 95% CI: [−0.05, 0.24]; p = .19).

The mean impact ratings, from highest to lowest, for 12 possible ways a caregiver's own personal life could be impacted by a diagnosis

TABLE 5 Mean caregiver impact rating from 1—"no impact" to 7—"extremely strong impact" for 12 specific impact topics

Specific impact	Mean impact rating (95% CI)	*n*
Emotional stress	5.99 (5.76–6.22)	88
Change in lifestyle	5.86 (5.64–6.09)	88
Health issues (stress, depression, fatigue, etc.)	5.30 (4.99–5.60)	88
Financial stress	5.09 (4.78–5.40)	87
Trying to balance caregiver roles w/ other family roles	5.00 (4.64–5.36)	88
Strain on family dynamic, relationships, marriage, etc.	4.94 (4.62–5.27)	87
Not able to make enough time for oneself (self-care)	4.90 (4.53–5.26)	87
Change in social life	4.86 (4.53–5.19)	88
Career changes and/or stress	4.83 (4.48–5.18)	88
Closer and more supportive family relationships	4.70 (4.41–4.98)	86
Personal growth	4.35 (3.97–4.73)	86
Gaining a sense of fulfillment or purpose	4.30 (3.95–4.64)	88

TABLE 6 Number and percent of caregivers that found each resource "very" or "extremely" useful (prior resource utilization) or would potentially find useful (no prior resource utilization)

Resources	Used (*N* = 29) *n* (%)	Found very/ extremely useful *n* (%)		Would potentially find useful *n* (%)
Brochures, pamphlets, handbooks, etc.	24 (85.7)	5 (20.8)	→ No prior resource utilization (*N* = 58) →	41 (70.7)
Down syndrome advocacy groups	23 (82.1)	10 (43.5)		42 (72.4)
Scientific literature	22 (78.6)	7 (31.8)		36 (62.1)
Educational workshops/conferences	16 (59.3)	7 (43.8)		41 (70.7)
Online forums/chats	12 (44.4)	3 (25.0)		17(29.3)
Online support group	9 (33.3)	2 (22.2)		30 (51.7)
Alzheimer's disease advocacy groups	9 (33.3)	3 (33.3)		24 (41.4)
In-person support group	8 (29.6)	4 (50.0)		27 (46.6)
Webinars	7 (25.9)	1 (14.3)		26 (44.8)

Note: Note for prior resource utilization: there were varying numbers of total responses for each resource due to caregivers not being required to provide a response for each resource. Note for no prior resource utilization: two of the 60 caregivers preferred not to answer this question, resulting in a total of 58 respondents for possible resource utilization.

of AD in an adult with DS can be seen in Table 5. Emotional stress was found to have the highest average impact rating (5.99), while gaining a sense of fulfillment or purpose was found to have the lowest average impact rating (4.30).

3.5 | Caregiver resource utilization

Among the 89 caregivers, 32.6% utilized resources that provide support and information regarding AD development in adults with DS and 67.4% of the caregivers had not utilized any resources on this topic. For caregivers who previously utilized resources, Table 6 illustrates the resources that were utilized and how many caregivers found each resource "very" or "extremely" useful. The majority (*n* = 24; 85.7%) of these caregivers noted that they used brochures, pamphlets, and handbooks. However, only 20.8% (*n* = 5) of these caregivers rated these resources as "very useful" or "extremely useful." Similarly, those caregivers with no prior resource utilization were asked to identify resources that they would find useful and would be willing to use (Table 6). These respondents expressed potentially finding DS advocacy groups (*n* = 42; 72.4%) most useful and online forums or chats (*n* = 17; 29.3%) least useful.

Caregivers were additionally asked if they have ever spoken to a healthcare professional about the risk of AD development in their adult with DS. Less than 50% of caregivers (*n* = 39; 43.8%) utilized healthcare professionals for AD information. Using a 7-point Likert scale, these caregivers were asked to rate how satisfied they were with their discussion with the healthcare professional. The average satisfaction score was 4.26 (*SD* = 1.35; 95% CI: [3.82, 4.69]), which translates to the "neither satisfied nor dissatisfied" rating.

3.6 | AD discussion with adult with DS

We also asked caregivers if they had discussed the subject matter of AD with their adult with DS. Caregivers could additionally add an explanation as to why they did or did not discuss this topic with their adult with DS. A total of 85 (95.5%) of the 89 caregivers that answered this question said that they had *not* discussed the topic. Common reasons for not having this discussion were that the adult with DS would not understand, that the adult with DS was too young for this to be a concern, and that the caregiver did not want to cause worry, anxiety, or depression. Of the four (4.5%) caregivers who did discuss this topic, reasons for discussing AD included needing to address an AD diagnosis in the adult's friend or family member and helping the adult with DS understand certain changes they were noticing in themselves.

3.7 | Open-ended survey questions

Throughout the survey, there were open-ended questions offered in text box format that invited study participants to leave additional comments. Representative comments are listed in Table 7, and the complete list of caregiver comments can be seen in Supplement A.

4 | DISCUSSION

As adults with DS are living into older decades, the topic of AD is becoming an increasingly relevant and concerning topic. This study served the purpose of gaining valuable insight into the lives of caregivers of aging adults with DS to determine their current state of knowledge, concerns, and need for resources.

TABLE 7 Open-ended survey questions and examples of caregiver comments

Open-ended survey questions example of caregiver comments
(1) If you have any additional concerns about a possibility of an Alzheimer's disease diagnosis in the individual that you care for with down syndrome, please describe them here (n = 27)
(1.1) "Since I am so much older, I only hope if this were to happen, the individuals who ended up caring for my son would be well qualified and would never do anything to hurt my son. I fought so much all his life for inclusiveness and just can't imagine him ending his life within an institutionalized setting."
(1.2) "I do not want her to be at the mercy of caregivers who could never love her as I do. I don't know how long I could physically manage her care."
(1.3) "Very concerned about the frustration that would develop in the individual when there is an awareness of deterioration in abilities, especially cognitive abilities."
(2) If you have any additional ways in which you believe a diagnosis of Alzheimer's disease in the individual that you care for with Down syndrome would impact your life as a caregiver, please describe them here: (n = 16)
(2.1) "Well—if I live long enough to see my daughter through this phase of her life then that will be the end of my life, too. I have, since the beginning, hoped to be able to care for her through her death. I am afraid of a future where she is suffering and frustrated and no one to care for her who loves and knows her like I do."
(2.2) "Sense of being overwhelmed and a spiritual crisis of feeling that it's just not fair."
(2.3) "I think it affects my own life tremendously. I have rheumatoid arthritis. Due to the amount of time I spend caring for my sister, I have had to put my own pain & treatment on the back burner. It is wearing me out and I know I'm getting joint destruction. I have great support from my husband but limited support from other sibling."
(3) Please list any additional resources you may find useful here: (n = 2; no prior resource utilization)
(3.1) "Should my son get Alzheimer's having all information to give to his caregiver and me information to help me as a mother would be very much appreciated."
(3.2) "Medications for symptoms and scripts as soon as possible."
(4) Please list any additional resources you have used here: (n = 6)
(4.1) "Information sharing with other families."
(4.2) "Since my daughter is only 25 I haven't done the kind of research I will do when she is older. I am hoping that the new energy that is going into DS research will give us more and better options."
(4.3) "Down syndrome National Convention."
(5) Please describe any additional resources you think would be helpful in answering any questions you may have about Alzheimer's disease in an adult with Down syndrome: (n = 9)
(5.1) "I DESPERATELY could use a support group that I could attend. I can't find one. It seems like we're teaching everyone else about aging Down syndrome—and their likelihood of getting Alzheimer's disease."
(5.2) "Professionals need more experience and knowledge of Down syndrome aging adults! Most important!! The aging process along with dementia is not fun at all and if other medical issues arise, it is very hard on the individual and caregiver."
(5.3) "Online support group aimed at DS plus Alzheimer's caregivers or family. List of appropriate residential support and options in various locations. Help in creating appropriate support/living places."
(6) What details about your discussion with the healthcare professional made you rate your level of satisfaction the way that you did? (n = 26)
(6.1) "I felt like I knew more from my Internet search."
(6.2) "We live in a very small rural area. there aren't any medical professionals who have had adequate experience or training in the Down syndrome/Alzheimer's situation. To find someone who has a working knowledge we would have to travel 100 miles."
(6.3) "His PCP is knowledgeable, caring and takes time to educate me. She (his PCP) takes any amount of time needed to listen to my concerns, and will follow-up with me if needed."
(7) Thank you for taking the time to complete this survey. Please feel free to use the following space for any questions, concerns, or comments you may have now that the survey is complete: (n = 29)
(7.1) "I have had my sister in my care for the last 12 years. I have felt like I've been out on an island by myself. There has to be more support groups, resources, & medical professional direction in caring for an aging DS…"
(7.2) "I hope this will help to develop a plan of action that can be used in the diagnoses and treatment of Alzheimer's in individuals with Down syndrome."
(7.3) "This is relatively new to me. From what I understand it is only recently being studied by the research community. I have a relative who is older and in the throes of the disease. And as a person who has observed the stages of her downward spiral for years and the father of a downs child I feel that I can corroborate symptoms and behaviors in both. It is frightening."

The knowledge exploration portion of this study revealed that there are some misconceptions present in this population of caregivers. This finding is in line with previous research that has noted a rather significant knowledge gap among caregivers and service providers (Carling-Jenkins et al., 2012). Nearly 52% of caregivers were unable to identify changes in behavior and personality as the most common presenting symptom of AD in an adult with DS. As mentioned previously, symptoms of DS tend to overshadow symptoms of AD, which can lead to a delay in diagnosis and implementation of intervention methods (Brotman, 2014). If caregivers do not know about the increased risk for AD, it is reasonable to speculate that these caregivers may not identify any warning signs or symptoms of the development of AD, instead regarding them as exacerbations of the adult's symptoms of DS. More education for both caregivers

and health providers is necessary to promote early detection of AD development in adults with DS to allow for proper intervention, therapies, and future planning. Additionally, approximately 36% of caregivers were unable to correctly state that not all individuals with DS will develop AD. Therefore, many caregivers falsely believe that a diagnosis of AD is inevitable for their adult with DS rather than just a possibility. Increased education is needed to provide caregivers and healthcare providers with accurate information.

Although full knowledge might have been lacking, the topic of AD was found to be a prominent concern for caregivers. About 83% of caregivers expressed moderate to extreme concern about the possibility of AD development in their loved ones with DS. Interestingly, none of the variables used for comparison (age, FAS, and medical concerns) significantly correlated to caregiver overall concern rating about a possible AD diagnosis. Further exploration of all of these relationships in a larger caregiver population would be needed to determine if the general trends found in this study would be recreated, solidified as a significant correlation, or revised.

This caregiver population rated quality of life for the adult with DS as their biggest concern should AD develop. When offered the opportunity to provide additional concerns or comments regarding this possibility, many caregivers wrote with strong emotion about the future care and life of the adult with DS, solidifying this topic as the highest-rated concern.

Just as the possibility of an AD diagnosis in their adult with DS was a high concern, this possibility was also rated to have a substantial impact on the lives of these caregivers. The majority of caregivers left comments that supported the highest impact rating for emotional stress.

Also similar to caregiver overall concern rating, most of the variables we used for comparison (FAS and medical concerns) did not have a statistically significant correlation to the overall rating of how a diagnosis of AD in the adult with DS would impact the life of the caregiver. However, age of the adult with DS did have a significant correlation with caregiver impact ratings. Again, impact ratings were higher for the caregivers of younger adults with DS. A possible explanation for this could be that caregivers caring for adults in the later age cohorts are more likely to be already dealing with symptoms of advanced aging in their adult with DS, and possibly early signs of AD. Therefore, for these caregivers, a diagnosis of AD may not have as strong of an impact on their already complex life as a caregiver of an older adult with DS. One must also consider the possibility that adults with DS in these older age cohorts may not have been mainstreamed like younger populations of individuals with DS are in today's current society. Therefore, this correlation may not be so much of an aspect of the adult with DS's functioning and health, but more so an aspect of caregiver expectations of life goals for their adult with DS.

The majority of caregivers had *not* yet utilized any resources to gain more information about AD development in adults with DS. However, these individuals reported that they would be most willing to use DS advocacy groups, brochures, educational workshops, or scientific literature. Interestingly, of the few caregivers who did utilize resources, they reported using these same resources most often. However, less than half of these caregivers found them to be "very" or "extremely" useful. This study did not specifically explore the reasoning behind caregivers' ratings of resource usefulness. However, one could speculate that the low usefulness ratings, as well as the lack of resource utilization, may be a result of the information not being immediately relevant to most of these caregivers. If an adult with DS is of a younger age and not showing any concerning signs of aging, AD may not be on the forefront of caregivers' minds. Additionally, due to technological advances, our society has shifted to a media culture where most information is easily accessed by a click of a button or a swipe of a finger. Social media platforms have quickly become popular sources of information. This societal shift may also help explain the lack of current resource utilization and perceived utility of available resources. If information is not easily and quickly accessible, straight to the point, or packaged in an aesthetically pleasing or entertaining way, then it will most likely not be utilized to an extensive degree. However, this thought must also take into account the ages of the caregivers seeking information. For instance, older caregivers may not utilize social media outlets for information gathering. Further exploration of resource utilization would provide beneficial information for DS advocacy groups and healthcare professionals to help tailor their resource materials to the needs of caregivers across varying generations. For example, most DS advocacy groups have a strong focus on the newborn and childhood periods as opposed to aging and DS. Therefore, there is an emerging need for adult programming and educational resources pertaining to not only AD, but the intricacies of aging and DS as a whole. One such comprehensive resource is the recent guidebook provided by the National Down Syndrome Society (NDSS): Alzheimer's disease & Down syndrome: A Practical Guidebook for Caregivers (NDSS, 2019). Unfortunately, caregiver oriented resources such as the NDSS guidebook are not as well-publicized or readily available as one would expect. Further adding to the issues and concerns surrounding resource utilization, a significant number of caregivers mentioned previously using or being interested in using scientific literature. Although scientific literature is a helpful resource, the information presented can be difficult to comprehend and can be very easily misconstrued, even for highly educated individuals. This raises the question whether caregivers are turning to scientific literature because they do not feel as though they can receive this information elsewhere.

Caregivers were asked to list any additional resources that they believed would be helpful in answering any questions they may have about AD in adults with DS. There was clear frustration expressed in some of these caregivers' responses regarding the lack of availability or possibly even knowledge of resources. Other participants simply stated that they were in need of a DS clinic. Due to the anonymous structure of this survey, it is not possible to know exactly from where participants were recruited. However, we widely enlisted the help of several DS organizations. Most, if not all, of these organizations provide opportunities for support groups, educational events, and connections to other families. Not being aware of these groups or not being able to readily access their support is a challenge for caregivers,

especially those who may live in underserved or more remote areas. Similar is true for those caregivers seeking a DS clinic. The NDSS includes a list of 76 DS specialty clinics, including location and contact information, on their website (Down Syndrome Specialty Clinics Database, http://www.ndss.org/Resources/Health-Care/Health-Care-Providers/). However, these clinics vary in what services they provide, what type of medical professionals are involved in providing care, and the ages of individuals with DS that they will accept as patients. Less than half of the listed clinics would follow a patient with DS throughout all of adulthood. Based on the location of clinics on this list and the age restrictions for some clinic sites, there are clearly several underserved states, specifically in regards to finding care for adults with DS.

When speaking about healthcare providers as a resource for information, only about 44% of caregivers had ever spoken to a healthcare professional about the risk of AD development in individuals with DS. Of these caregivers, about 62% rated this discussion as "moderately satisfied" or worse. Caregivers were asked to comment on why they gave their specific satisfaction score. Not all caregiver responses were negative, however. Multiple caregivers commended the adult with DS's physicians for their care, knowledge, and sensitivity. Generalizations about the utility of healthcare providers, as a whole, cannot be made by these observations alone. However, many caregivers felt that they should not bear the responsibility of educating the healthcare professionals. This could potentially tie into why many caregivers in this study reported turning to scientific literature for information about this topic. Nonetheless, the resources being accessed by these caregivers to gain information are also readily available to healthcare professionals. Making sure these caregivers have referrals and access to reputable adult DS clinics, reliable providers, and useful resources is key for this population.

Gaining insight from this study on specific caregiver knowledge, concerns, possible impacts, and resource utilization provides a great deal of invaluable information to add to our arsenals when dealing with this population of caregivers. Although each caregiver is unique, this information helps lay the groundwork for anticipatory guidance. Previous research has shown that adequately planning for the future is essential for caregivers in developmental disability populations and helps to avoid hasty decision-making in the face of a new AD diagnosis (Heller & Caldwell, 2006). If we can plant the seed for caregivers to begin thinking about these potential concerns and impacts well before they are possibly thrust into the crisis of a new AD diagnosis, we may be able to promote more positive adjustment outcomes. This anticipatory guidance would be an ideal niche for genetic counseling, therefore justifying the significant role of a genetic counselor in adult DS clinics. Genetic counselors have the skill set to provide the psychosocial support required for these types of sensitive discussions and can aid caregivers in education, coping, decision-making, and finding appropriate support services.

5 | LIMITATIONS

This study was limited by the possibility of ascertainment bias. Participants were recruited from study advertisements distributed by four DS advocacy groups and two adult DS clinics. It is possible that this study population represents caregivers that are more actively involved in these groups and healthcare services. Additionally, caregivers with high levels of concern or knowledge regarding this subject matter may have been more motivated to respond to the survey. Therefore, the results of this study may be an over-representation of caregiver knowledge, concerns, impacts, and resource utilization. Caregiver knowledge may also be over-represented due to the fact that participants were not monitored while taking this online survey. It is also possible that caregivers utilized outside resources to aid in their answering of the knowledge questions.

We further acknowledge that this study could have benefited from a larger sample size. However, we hope that our results enable future researchers to build upon the trends observed in our study. Additionally, this study's caregiver population may not be demographically or geographically representative of the caregivers of adults with DS population as a whole. Of note, this study was limited by the low number of responders who were caring for an adult with AD and DS. Future research directed at this cohort could help better identify resources that have been effective for caregivers when the adult with DS develops AD. Our participants consisted of caregivers who were majority female, non-Hispanic, Caucasian, and who received some upper-level education. Caregivers were also recruited predominantly from Ohio organizations and clinics, with one recruitment clinic being located in Illinois. However, social media was used as one of many distribution methods and it is difficult to assess the impact this had on the geographical location of caregiver recruitment.

A final limitation was the absence of validated survey instruments available in the literature that gathered the information this study was aiming to investigate. Aside from the functional activity scale (Skotko et al., 2011), the questions utilized in this survey were unique to this specific study.

6 | CONCLUSION

This study's data support previous research findings that there is a lack of caregiver knowledge and awareness about the risk of AD in adults with DS. The topic of AD development is clearly an area of immense concern for caregivers and impacts their own personal life to great degrees. This study suggests that this caregiver population is not receiving the adequate information, resources, and support that they need during this stage of caregiving. Our data provide insight on how to better support these caregivers, such as resource personalization and development, increased utilization of genetic counselors for anticipatory guidance, and an increase in appropriate education of both caregivers and healthcare professionals. Advocacy groups and healthcare providers have the opportunity to play a vital role in supporting the education and needs of this caregiver population. This information also helps build the foundation for future interview or focus group based studies that can take these findings and explore them further and in more detail. There are presumably many underlying caregiver emotions, thought processes and opinions that could not feasibly be explored by the questions in this study that could also help

offer more insight into this caregiver population. Overall, this study adds substantial data and psychosocial information to the scientific literature that will aid in caring for not only adults with DS, but their caregivers as well.

CONFLICT OF INTERESTS

All contributors, with the exception of Dr. Brian Skotko, have no conflicts of interest to disclose. Dr. Skotko occasionally consults on the topic of Down syndrome through Gerson Lehrman Group. He receives remuneration from Down syndrome nonprofit organizations for speaking engagements and associated travel expenses. Dr. Skotko receives annual royalties from Woodbine House, Inc., for the publication of his book, *Fasten Your Seatbelt: A Crash Course on Down Syndrome for Brothers and Sisters*. Within the past 2 years, he has received research funding from F. Hoffmann-La Roche, Inc. and LuMind Research Down Syndrome Foundation to conduct clinical trials for people with Down syndrome. Dr. Skotko is occasionally asked to serve as an expert witness for legal cases where Down syndrome is discussed. He serves in a nonpaid capacity on the Honorary Board of Directors for the Massachusetts Down Syndrome Congress, the Board of Directors for the Band of Angels Foundation, and the Professional Advisory Committee for the National Center for Prenatal and Postnatal Down Syndrome Resources. Dr. Skotko has a sister with Down syndrome.

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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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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