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Young adult perceptions of JUUL and other electronic cigarette pod devices

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Complete List of Authors:	Keamy-Minor, Emily; University of California San Francisco School of Medicine, Medicine McQuoid, Julia; University of California San Francisco School of Medicine, Medicine Ling, Pamela; University of California San Francisco School of Medicine, Medicine
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Young adult perceptions of JUUL and other electronic cigarette pod devices

1. **Emily Keamy-Minor, AB**
Emily.Keamy-Minor@ucsf.edu
Center for Tobacco Control Research and Education, University of California, San Francisco
530 Parnassus Ave, Suite 366, San Francisco, California 94143

2. **Julia McQuoid, PhD**
Julia.mcquoid@ucsf.edu
Center for Tobacco Control Research and Education, University of California, San Francisco
530 Parnassus Ave, Suite 366, San Francisco, California 94143

3. **Pamela M. Ling, MD MPH** (Corresponding author)
Pamela.Ling@ucsf.edu
Center for Tobacco Control Research and Education,
Division of General Internal Medicine, Department of Medicine
University of California, San Francisco
530 Parnassus Ave, Suite 366, San Francisco, California 94143
(415) 514-8627

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Ms. Keamy-Minor contributed to data collection, coded all transcripts, wrote analytical memos, and led manuscript writing. Dr. McQuoid contributed to study design, data collection, analytical framework, and contributed to manuscript writing. Dr. Ling obtained funding, and contributed to study conception, design, data collection and manuscript writing. All authors contributed to data analysis, critical revision of the manuscript, and approved the final manuscript for submission.

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Abstract

Objective: Electronic cigarettes (e-cigarettes) which utilize prefilled 'pods' (pod devices) entered the US market in 2015. One brand, JUUL, captured more than half the e-cigarette market in early 2018, and the FDA recently warned its manufacturer about adolescent uptake. This is the first qualitative study to describe distinct features of pod devices that appear to contribute to their popularity among young people.

Study Design: Qualitative interview study of young adults who had used pod devices recruited from Facebook, other social media, street recruitment, and via snowball sampling within California. Most participants were from the San Francisco Bay Area. Young adults (ages 18-28) using multiple tobacco products (cigarettes, e-cigarettes, and/or smokeless tobacco) were recruited; of the sample of 60 participants, ten reported experience with pod devices.

Results: Ten participants and had used a pod device in the past year. Of these, 7 still used a pod device at the time of the interview and 5 did so daily. Nearly all participants smoked cigarettes in the past month (n=9); none were daily smokers. Participants highlighted some distinct aspects of pod devices that facilitated use, including their aesthetic similarity to personal electronics, high levels of nicotine delivery with distinct psychoactive effects, more discreet and shorter duration use sessions, and greater social acceptability than more ostentatious e-cigarettes.

Conclusions: Pod devices' unique characteristics likely encourage pod device uptake among young people. Limitations on advertising in youth channels, flavors, and distribution, and education about nicotine addiction may decrease initiation among young people and nonsmokers.

Strengths and Limitations of the Study:

Strengths

- Novel and timely topic with almost no published research to date
- Qualitative study provides richer insights into why pod devices are becoming so popular among youth, complementing the cross sectional survey data published to date
- The sample, while limited, represents the "leading edge" of the epidemic, as young adults are early adopters and influencers for adolescents and others

Limitations

- Limited number of participants from a single geographic area limits generalizability
- Study was of poly-tobacco users, not explicitly recruited because of pod device use

INTRODUCTION

'Next generation' electronic cigarettes (e-cigarettes) that utilize flavored 'pods' emerged in the US market in 2015.[1] Pods are typically prefilled e-liquid cartridges inserted into a closed-system e-cigarette device. Sales of 'pod devices' have markedly increased; the most popular brand, JUUL, captured 32% of the e-cigarette market in 2017 and 49.5% by January 2018.[2, 3] Although JUUL was the first of these products,[4] similar devices, including MyJet, My Von Erl, Phix, and more recently, Suorin[5] are now available. Cigarette companies have begun producing pod devices: Imperial Tobacco purchased My Von Erl and launched it as a line extension of the blu electronic cigarette, called *my*blu, in early 2018.[6]

JUUL's rapid rise in popularity was accompanied by marketing on social media widely used by young people, including Twitter, Instagram, and YouTube.[4] While some argue pod devices and other e-cigarettes may encourage smoking cessation,[7] these devices can also recruit youth to start nicotine use.[8] It is important, therefore, to understand why pod devices have become popular among young people.

A 2017 report on e-cigarette marketing[9] noted JUUL advertisements emphasized the product's "high tech features" and flavors.[10-12] Kavuluru and colleagues' analysis of JUUL messages on Twitter and Reddit found that brand mentions were associated with places frequented by young adults (e.g., 'school', 'class,' 'dorm') and youthful activities (e.g., dressing in JUUL-themed

costumes).[2] Messages on these sites included discussions about concealing use and strategies for obtaining pods underage.

To our knowledge, no prior studies have explored young adults' perceptions and use of pod devices compared to other tobacco products. This paper draws from semi-structured interviews with 10 young adult poly-tobacco users in California to understand: 1) How young adults perceive and use next generation pod devices; and 2) How, if at all, their use of pod devices differs from that of conventional cigarettes and other e-cigarettes.

METHODS

Participants

Ten interviews (n=10) were conducted as part of a larger qualitative study of young adult poly-tobacco users in California (n=60) between January-August 2017 (for further description of the parent study, see: McQuoid, J, Keamy-Minor, E, Ling, PM, A practice theory approach to understanding poly-tobacco use). Participants used at least two of the following within the past 30 days: cigarettes, e-cigarettes, or smokeless tobacco. The study was designed prior to the popularization of pod devices, so did not specifically recruit pod device users or systematically assess pod devices in the interview guide. However, rich discussion of pod device use arose with the 10 participants included in this paper.

Participants were 18-28 years old and had used a pod device (JUUL or My Von Erl) in the past year. Of these, 7 still used a pod device at the time of the interview and 5 did so daily. Most current users owned their device; the two non-daily users shared a friend's device. Similar to national patterns of young adult smoking,[13, 14] nearly all participants smoked cigarettes in the past month (n=9) but none were daily smokers (Table 1).

Table 1. Participant characteristics and tobacco product use

Participant pseudonym	Gender	Age	Pod device brand	Current or former pod device use[2]	Days of pod device use in past month[3]	Days of cigarette use in past month
James	M	28	My Von Erl[1]	Current	6	25
Ben	M	20	JUUL	Current	6	8
Isabelle	F	21	JUUL	Former	N/A	12
Robert	M	26	JUUL	Former	N/A	23
Brandon	M	19	JUUL	Current	30	4
Liam	M	26	My Von Erl	Current	30	25
David	M	23	My Von Erl	Former	N/A	15
William	M	18	JUUL	Current	30	0
Sarah	F	19	JUUL	Current	30	15
Brian	M	21	JUUL	Current	30	4

[1] Participant did not provide a brand name, but physical description of device and flavor options is consistent with My Von Erl
[2] Three participants reported using pod devices in the past but were not currently using at the time of the interview
[3] Participants reporting non-daily pod device use did not own their devices and instead shared with a friend

Study Procedures

Participants were recruited through ads on Facebook and Instagram and completed online eligibility screening. Eligible participants were 18-29 years old and used more than one tobacco

product in the past month, and completed questionnaires about tobacco product use and sociodemographic characteristics.

Sixty-minute interviews were conducted primarily in person in university seminar rooms, with some by phone. Interview topics included use of different tobacco products, experiences and motivations for use, perceived benefits, and how and why different tobacco products were used in daily routines. Participants received a $100 Amazon gift card. Ethics approval for this study was granted by [INSERT UNIVERSITY NAME] Institutional Review Board. Pseudonyms have been applied to protect participant confidentiality.

Data Analysis

The initial coding scheme included product types, product use routines, and product perceptions. The code book was refined after closely reading six transcripts and iterative group discussions. Subsequently, the first author coded all interviews. The coding scheme was further refined in iterative team meetings to accommodate emergent themes. Rich content regarding pod devices emerged in 10 transcripts, which are the subject of this analysis. The first author prepared detailed memos describing and analyzing relevant excerpts and discussed with the second author. The third author independently read the same excerpts to triangulate interpretation. All three authors discussed the memos and excerpts, identifying the following themes: sensory experience, health effects, aesthetic appeal, convenience, nicotine delivery, contexts of use, and social meanings.

Patient and Public Involvement

Research questions were informed by feedback from prior qualitative studies conducted with the target population of young adult tobacco users.[15] Participants were not directly involved in the study design, recruitment, and conduct of the study. A simplified summary of results has been disseminated to all participants and copies of published articles will be made available to those who request further information.

RESULTS

Many perceived benefits of pod devices were consistent with previous findings on e-cigarettes (see also McQuoid, J, Keamy-Minor, E, Ling, PM, A practice theory approach to understanding poly-tobacco use).[15-18] For example, participants noted pleasurable sensory experiences including good taste and smell, a quickly dissipating scent unlike cigarettes, and less noticeable throat irritation than from cigarettes.[17] Also similar, pod devices were considered less harmful to health than cigarettes.[15] Participants distinguished between "real" smoke and "vapor," expressing that the latter was most likely better for their health. This was true even for participants who had not smoked cigarettes regularly prior to pod device use.

Participants' accounts of pod devices differed from those of other e-cigarettes in several notable ways. These included the unique ***aesthetic appeal*** of pod devices, ability to ***deliver nicotine*** at high concentrations, and the ***convenience*** of using them quickly and discreetly. ***Contexts of use*** and ***social meanings*** also appeared to differ from other e-cigarettes.

Aesthetic Appeal

Pod devices resemble personal electronics, and charge via USB cable. Participants described them as "sleek" (Brian) and "elegant looking" (James). Some participants compared the shape to that of a flash-drive:

> *"Pick up a pen. You know like this USB flash-drive? It's like one of those but only a little bit smaller."* (Brandon)

These devices can also be charged on a computer, reinforcing associations with electronic devices. One participant described how JUUL use was linked to his friend's computer use:

> *"If I'm at his house and we're just sitting on the couch watching something, he's always got his computer out, and [the JUUL] charges in a little connector thing. And you can just pick it up and then do it*." (James)

Compared to modifiable e-cigarette "box mods", pod devices are smaller and more 'user friendly'. One participant described the appeal of the device's simple design:

> *"I did pick up something called a My Von Erl, which is smaller than this tape recorder. […] It's like little pods [...]. And you stick it in. And, like, it's really simple."* (David)

Lastly, one participant's experience trying JUUL seemed to reflect new technology early adoption; it was exciting at first, but this novelty wore off:

> *"I mean honestly, it's like a new car. You know, first few years are great. It's a newer car than most others. I'm talking a brand new car. Like you get it right off the lot. It's got like ten miles on it, right? And then a few years later, it's not new anymore. It's not interesting. […] [I]t kind of loses its value as being new and fun and exciting."* (William)

Nicotine Delivery

Although My Von Erl pods were sold in four different nicotine levels at the time of data collection (0 mg/mL, 9mg/mL, 18mg/mL and 36 mg/mL), JUUL pods were available only in 59 mg/ml per pod.[19] Discussion of nicotine content for My Von Erl was limited. Participants using JUUL for more than a month (Brandon, Sarah, Brian), noted JUUL's high concentration of nicotine. One described JUUL's standardized pods as "ridiculously strong" (Brian). Another started his description of JUUL with the observation, "It's like a lot of nicotine, from what I understand" (Brandon).

In addition to identifying JUUL's nicotine content, participants also described physical sensations likely attributable to nicotine delivery. One participant (William) described the JUUL sensation as "a minute of just complete relaxation." Others described triggers for JUUL similar to smoking triggers, such as following meals (Sarah) or after exercise (Brandon). A few participants experienced reduced cravings for nicotine (Liam). Sarah described a reduced desire to smoke cigarettes after daily use of JUUL:

> *"But for the most part, it's just JUUL these days. Because it's not that I don't like smoking cigarettes - like I do still enjoy it. But I just know it's really not, like, great for me and this is more convenient, smells better, tastes better, and when I'm using it more, it's like more appealing. Like the less you're using cigarettes, the less appealing they become to you."* (Sarah)

While some participants seemed to seek nicotine, others were concerned about addiction. Given JUUL's single nicotine concentration, some participants found it difficult to taper or reduce their nicotine intake, a strategy favored by Brian during past cessation attempts with a box mod:

> *"I don't want to be addicted to [nicotine], and the best way to quit would be - or the best way for me to quit would be to control it. And to control it, I think it's a lot easier with an e-cigarette that isn't the JUUL. The JUUL you can't control shit, but the, like, box mod you actually can."* (Brian)

Others were confident in their ability to avoid dependence by imposing limits on use. For example, William reported using JUUL in the morning to "get the most effect", which might be analogous to smoking shortly after waking, an indicator of nicotine addiction.[20] Nevertheless, he considered himself to be at low-risk for addiction:

> *"You know, the only part of it is [sic] that is concerning is the nicotine usage and I'm very, very responsible. So, I didn't really see myself getting addicted needless to say."* (William)

The nicotine level in pod devices appeared to influence the frequency and duration of participants' use in everyday life. Sarah reported taking fewer puffs at a time when using her JUUL (puffs per session) than she does with cigarettes. However, she reported that she uses her JUUL at more points throughout the day (sessions per day):

> *"But when I have the JUUL, it's honestly - each hit is a lot stronger, so it's like I'm going to be sitting there for like ten seconds and using it. […] But then I'm going to want to use it again, because I didn't get the whole same amount of nicotine [as compared to a cigarette]."* (Sarah)

Brian also took fewer puffs at a time when using his JUUL than with his box mod:

> "*[I]t's just, like, I would die if I used it all day. I don't feel the need to, like, constantly be hitting it if I have it on me.*" (Brian)

Most participants reported that they typically used their device for fewer than 3 minutes at a time, with some taking up to a dozen hits over several minutes, and others taking several consecutive hits in under a minute. These variations in use resulted in most participants gauging use by how long a cartridge lasted, varying from 4-5 days (light use) to 1 day (heavy use).

Convenience

Pod devices are small, light and highly portable. The closed pods are tidier than some refillable devices, which can leak e-liquid. As a result, they are more "pocketable" than larger e-cigarettes (David). Pod devices also produce smaller aerosol clouds, allowing discreet use in public places. Liam's decision to switch from a box mod to a My Von Erl was partially motivated by a desire to be "as discreet as possible":

> *"So, ultimately, [the box mod] was just, like, too bulky. It was, like - it's a really big - like, a really big device. And so, yeah, just it wasn't easy to carry around, and it just, like, the smoke output or the vapor output was just, like - just too, too much, just a little too crazy."* (Liam)

Other participants liked the idea of discretion, even if they did not take advantage of this feature. Liam noted that JUUL could be used discreetly "if you needed to." Ben reported his friends had concealed their use of JUUL on airplanes. The speedy and intense nicotine delivery of JUUL (noted above), facilitated taking a quick "hit" between activities (Sarah), enabling integration of pod device use more conveniently into the flow of the day.

Contexts of Use

Participants reported using pod devices in places and situations similar to other e-cigarettes (McQuoid, J, Keamy-Minor, E, Ling, PM, A practice theory approach to understanding poly-tobacco use),[21, 22] such as indoors at home and in cars, while relaxing with friends, after eating, and on breaks from work. They also noted minimizing use around adults and strangers. However, there were some indications that pod devices may be informally permissible in spaces where tobacco use is prohibited. This may be due to the small device size and minimal aerosol cloud. For example, unlike smoking, Sarah was allowed to use her JUUL indoors at her catering job even when she was not on break:

> *"I usually just have my JUUL on hand, and if I'm ever in a behind-the-scenes setting, I'm allowed to just use that. So I'll just continuously use that throughout my work shift."* (Sarah)

Social Meanings

Some participant accounts demonstrated that pod devices may have instigated a shift in the social meanings associated with using e-cigarettes. Social meanings here refer to broader understandings of the social significance of using e-cigarettes, including social acceptability.[23] While large box mods can evoke stereotypes of ostentation or disrespect, (consistent with findings from McQuoid, J, Keamy-Minor, E, Ling, PM, A practice theory approach to understanding poly-tobacco use), pod devices may not be subject to this stigma. For example, unlike other e-cigarettes, pod devices are "just really well accepted" among James' friends. Brian contrasts the obnoxiously performative connotation of e-cigarettes with use of pod devices:

"[S]o I went and bought an e-cigarette, and then I felt really awkward using e-cigarettes 'cause they're douchey, and so I got a JUUL because JUULs, for some reason, aren't douchey." (Brian)

The proliferation of pod devices throughout participants' social networks further highlights social acceptability. Most participants reported commonly sharing and using with friends. By the time Brandon first tried JUUL, half of his friends had already purchased their own device. Sarah and her best friend purchased JUULs at the same time, intending to switch to JUUL from cigarettes together.

DISCUSSION

This paper is the first to report on young adults' perceptions and uses of pod devices in a way that may explain their popularity. We found that pod devices share many similarities with other e-cigarettes, including their desirable taste, smell, and perceived health benefits.[15-18, 21] However, several distinguishing features were also evident. Participants enjoyed the 'tech appeal' aesthetic and associated pod devices with user-friendly personal electronics.[9] JUUL pods were perceived to deliver a high dose of nicotine, enabling shorter consumption sessions. Pod devices' portability and discreet clouds made them particularly convenient. These characteristics appear to lend pod devices to inconspicuous use in a wider variety of formally prohibited tobacco use contexts, including workplaces and airplanes. Finally, pod devices may have begun to reduce the social stigma previously associated with large 'box mod' devices.

Some characteristics of pod devices may help explain their appeal to younger populations. Associations with friendly and ubiquitous personal electronic devices rather than deadly and stigmatized tobacco products may facilitate use by young people, including nonsmokers. These characteristics paired with social media advertising may facilitate uptake among the young, particularly as social media content facilitates modeling and normalizes use.[3, 4]

Use of pod devices by youth and nonsmokers is particularly concerning as many participants readily spoke of strong nicotine delivery. Descriptions of situational triggers and early morning use suggests a risk of developing (perhaps unrecognized) nicotine dependence. Education about signs of nicotine addiction may also deter experimentation or motivate users to quit. Removal of flavors, offering reduced nicotine strength pods, restricting advertising in youth media channels, and limits on distribution of pod devices might reduce uptake by youth and nonsmokers. On the other hand, powerful nicotine delivery may facilitate pod devices' substitution for cigarettes, and some pod users spoke of decreased cigarette craving. The efficacy of pod devices for smoking cessation should be examined in randomized clinical trials; none have been published to date.

These findings also suggest several strategies for future research. Discrepancies between e-cigarette prevalence and sales,[4] suggest that pod device may be inadequately captured on existing surveillance instruments perhaps due to distinct appearance, brands, and terminology for use (e.g., 'JUULing').[3] As the number and variety of nicotine products proliferate, measures to capture total nicotine intake and dependence need to be developed and should include novel nicotine delivery devices. Pod device use patterns and experiences should be examined

separately from other e-cigarettes. Triangulating market research and epidemiological surveillance data may better characterize novel product uptake by different audiences; surveillance measures need to evolve as quickly as the e-cigarette market.

Limitations

This study did not specifically recruit pod device users, so the number of participants was small. However, participants were able to provide rich descriptions of their products and how they used them. The accounts provided here reflect early 2017 pod devices, and do not include planned changes in the nicotine strengths in JUUL pods[24] or newer refillable pod devices.[25] Further, our analysis did not differentiate between young adults who were using pod devices as a cigarette cessation aid and those who were never established smokers. Finally, this cross sectional analysis cannot determine whether participants progressed to cigarette use or were successful in sustaining a smoking cessation attempt. The differences in uses and perceptions between young adults using pod devices to quit smoking with those who had never smoked prior to pod device initiation should be examined in future.

CONCLUSION

The tobacco product landscape is rapidly changing. Pod devices appear to have catalyzed a shift in how many young adults perceive and use tobacco and nicotine. Pod devices' associations with personal electronics, efficient nicotine delivery, appealing flavor and odor, convenience, and greater social acceptance encourages uptake and use by young adults. As companies promoting new e-cigarette devices replicate these product features and utilize youth media for promotion, these devices are likely to continue to be rapidly adopted by young people. Limits on advertising,

availability, and abuse liability of pod devices, and public education to counter industry messages normalizing nicotine use may counteract these trends.

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1. **Emily Keamy-Minor, AB**
eekm@stanford.edu
Center for Tobacco Control Research and Education, University of California, San Francisco
530 Parnassus Ave, Suite 366, San Francisco, California 94143

2. **Julia McQuoid, PhD**
Julia.mcquoid@ucsf.edu
Center for Tobacco Control Research and Education, University of California, San Francisco
530 Parnassus Ave, Suite 366, San Francisco, California 94143

3. **Pamela M. Ling, MD MPH** (Corresponding author)
Pamela.Ling@ucsf.edu
Center for Tobacco Control Research and Education,
Division of General Internal Medicine, Department of Medicine
University of California, San Francisco
530 Parnassus Ave, Suite 366, San Francisco, California 94143
(415) 514-8627

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Ms. Keamy-Minor contributed to data collection, coded all transcripts, wrote analytical memos, and led manuscript writing. Dr. McQuoid contributed to study design, data collection, analytical framework, and contributed to manuscript writing. Dr. Ling obtained funding, and contributed to study conception, design, data collection and manuscript writing. All authors contributed to data analysis, critical revision of the manuscript, and approved the final manuscript for submission.

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Abstract

Objective: Electronic cigarettes (e-cigarettes) which utilize prefilled 'pods' (pod devices) entered the US market in 2015. One brand, JUUL, captured more than half the e-cigarette market in early 2018, and the FDA recently warned its manufacturer about adolescent uptake. This is the first qualitative study to describe distinct features of pod devices that appear to contribute to their popularity among young people.

Design: Qualitative interview study of young adults who had used pod devices recruited from Facebook, other social media, street recruitment, and via snowball sampling within California.

Setting: Participants were from California, with most from the San Francisco Bay Area.

Participants: Young adults (ages 18-29) using multiple tobacco products (cigarettes, e-cigarettes, and/or smokeless tobacco) were recruited. Of the sample of 60 participants, 24 were included in this analysis: 10 who reported experience with pod devices and 14 who used other non-pod e-cigarette devices.

Results: Ten participants had used a pod device in the past year. Of the pod device users, 7 still used a pod device at the time of the interview and 5 did so daily. Nearly all pod device users smoked cigarettes in the past month (n=9); none were daily smokers. The 14 participants who used non-pod devices provided a point of comparison. Participants highlighted some distinct aspects of pod devices that facilitated use, including their aesthetic similarity to personal electronics, high levels of nicotine delivery with distinct psychoactive effects, more discreet and shorter duration use sessions, and greater social acceptability than more ostentatious non-pod e-cigarettes.

Conclusions: Pod devices' unique characteristics likely encourage pod device uptake among young people. Limitations on advertising in youth channels, flavors, and distribution, and education about nicotine addiction may decrease initiation among young people and nonsmokers.

Strengths and Limitations of the Study:

Strengths

- Novel and timely topic with almost no published research to date
- Qualitative study provides richer insights into why pod devices are becoming so popular among youth, complementing the cross sectional survey data published to date
- The sample, while limited, represents the "leading edge" of the epidemic, as young adults are early adopters and influencers for adolescents and others

Limitations

- Limited number of mostly male participants who used pod devices from a single geographic area
- Study was of poly-tobacco users; participants who used pod e-cigarette devices were not purposively sampled

Kudos Plain Language Summary:

This is one of the first studies of the use of JUUL and other new e-cigarette "pod devices" among young adults in California. We analyzed interviews from 10 pod device users and 14 users of other types of e-cigarettes, and found several features of pod devices that make them especially appealing. These features included their similarity to personal electronics, high levels of nicotine delivery, more discreet use, and greater social acceptability. Addressing these features may discourage continued initiation among young people.

INTRODUCTION

'Next generation' electronic cigarettes (e-cigarettes) that utilize flavored 'pods' emerged in the US market in 2015.(1) Pods are typically prefilled e-liquid cartridges inserted into a closed-system e-cigarette device. Sales of 'pod devices' have markedly increased; the most popular brand, JUUL, captured 32% of the e-cigarette market in 2017 and 49.5% by January 2018.(2, 3) Although JUUL was the first of these products,(4) similar devices, including MyJet, My Von Erl, Phix, and Suorin(5) are now available. Cigarette companies have begun producing pod devices: Imperial Tobacco purchased My Von Erl and launched it as a line extension of the blu electronic cigarette, called *my*blu, in early 2018.(6)

JUUL's rapid rise in popularity was accompanied by marketing on social media widely used by young people, including Twitter, Instagram, and YouTube.(4) While some argue pod devices and other non-pod e-cigarettes may encourage smoking cessation,(7) these devices can also recruit youth and young adults to start nicotine use.(8) It is important, therefore, to understand why pod devices have become popular among young people.

A 2017 report on e-cigarette marketing(9) noted JUUL advertisements emphasized the product's "high tech features" and flavors.(10-12) Kavuluru and colleagues' analysis of JUUL messages on Twitter and Reddit found that brand mentions were associated with places frequented by young adults (e.g., 'school', 'class,' 'dorm') and youthful activities (e.g., dressing in JUUL-themed costumes).(2) Messages on these sites included discussions about concealing use and strategies for obtaining pods underage.

To our knowledge, no prior studies have explored young adults' perceptions and uses of pod devices compared to other tobacco products. This paper draws from semi-structured interviews with 24 young adult poly-tobacco users in California to understand: 1) How young adults perceive and use next generation pod devices; and 2) How, if at all, their use of pod devices differs from that of conventional cigarettes and other non-pod e-cigarettes.

METHODS

Study Procedures

Participants were recruited through ads on Facebook and Instagram and completed online eligibility screening. Eligible participants were 18-29 years old and used more than one tobacco product in the past month. All participants completed questionnaires about tobacco product use and sociodemographic characteristics prior to interviews.

Sixty-minute semi-structured, in-depth interviews were conducted primarily in person in university seminar rooms, with some by phone, and were audio recorded. Interview topics included use of different tobacco products, experiences and motivations for use, perceived benefits, and how and why different tobacco products were used in daily routines. Participants received a $100 gift card. Ethics approval for this study was granted by the University of California, San Francisco Institutional Review Board, and all participants gave informed consent for participation. Pseudonyms have been applied to protect participant confidentiality.

Data Analysis

The initial coding scheme included product types, product use routines, and product perceptions. The third author created the initial codebook after closely reading six transcripts and holding group discussions during data collection. The coding scheme was further refined in iterative team meetings with the first and second authors to accommodate emergent themes after the first 12 transcripts had been coded by the first author. The first author applied the final coding scheme to the rest of the transcripts. Transcripts were ranked in order of semantic richness. Excerpts from 18 of the richest transcripts regarding participants' e-cigarette use were read in tandem by the first and second author. From these in-depth readings, detailed memos regarding emerging categories of interest (e.g., characteristics of different e-cigarette devices) were made.(13) Four of these 18 transcripts contained pod device content. An additional 6 transcripts that had not been included in the tandem reading contained content regarding pod devices. These were also included in this analysis to supplement content on pod devices, for a total of 24 transcripts. Additional detailed memos were made by the first author describing and analyzing relevant pod device content from these excerpts, which were discussed with the second author. Saturation regarding e-cigarette use was reached after 24 transcripts. The third author performed an independent reading of pod device excerpts. All three authors discussed the memos and excerpts, identifying the following themes regarding unique characteristics of pod devices: sensory experience, health effects, aesthetic appeal, convenience, nicotine delivery, contexts of use, and social meanings.

Participants

This paper draws from 24 interviews with participants who were current e-cigarette users. Of the 24 interviews reported in this paper, 10 participants were current or former pod-device users and

14 were current non-pod e-cigarette users (e.g. small "cigalike" devices resembling cigarettes, medium devices like 'vape pens,' and large 'tank' or 'box mod' devices). The study was designed prior to the popularization of pod devices, so did not specifically recruit pod device users or systematically assess pod devices in the interview guide.

The 10 pod-device using participants were 18-28 years old and had used a pod device (JUUL or My Von Erl) in the past year. Seven still used a pod device at the time of the interview and, of these, 5 did so daily. Most current pod device users owned their device; the two non-daily users shared a friend's device. Similar to national patterns of young adult smoking,(14, 15) nearly all pod-device using participants smoked cigarettes in the past month (n=9), but none were daily smokers (Table 1).

Table 1. Participant characteristics and tobacco product use in past month

Participant pseudonym	Gender	Age	Pod device brand	Current or former pod device use[2]	Days of pod device use[3]	Days of non-pod ENDS use by device size[4]			Days of cigarette use
						Small	Medium	Large	
William	M	18	JUUL	Current	30	0	12	0	0
Sarah	F	19	JUUL	Current	30	0	0	2	15
Brian	M	21	JUUL	Current	30	0	0	0	4
Brandon	M	19	JUUL	Current	30	0	0	5	4
Ben	M	20	JUUL	Current	6	0	0	1	8
Isabelle	F	21	JUUL	Former	N/A	2	10	0	12
Robert	M	26	JUUL	Former	N/A	0	0	0	23
Liam	M	26	My Von Erl	Current	30	0	0	0	25
James	M	28	My Von Erl[1]	Current	6	0	0	0	25
David	M	23	My Von Erl	Former	N/A	0	0	30	15
John	M	21	N/A	N/A	N/A	30	30	30	25
Adam	M	20	N/A	N/A	N/A	0	0	15	25

Michael	M	27	N/A	N/A	N/A	5	4	5	5
Emily	F	23	N/A	N/A	N/A	5	0	0	30
Khaled	M	23	N/A	N/A	N/A	0	0	10	30
Victoria	F	28	N/A	N/A	N/A	5	10	0	30
Ajay	M	28	N/A	N/A	N/A	0	3	3	15
Esther	F	24	N/A	N/A	N/A	3	0	30	0
Mathew	M	24	N/A	N/A	N/A	0	2	0	15
Luis	M	24	N/A	N/A	N/A	0	0	15	1
Josh	M	24	N/A	N/A	N/A	22	0	30	30
Mark	M	29	N/A	N/A	N/A	3	0	3	2
Samuel	M	26	N/A	N/A	N/A	0	0	3	7
Carlos	M	20	N/A	N/A	N/A	0	1	0	20

[1] Participant did not provide a brand name, but physical description of device and flavor options is consistent with My Von Erl
[2] Three participants reported using pod devices in the past but were not currently using at the time of the interview
[3] Participants reporting non-daily pod device use did not own their devices and instead shared with a friend
[4] Participants were presented with descriptions and pictures of small, medium, and large ENDS. Small devices consisted of disposable and rechargeable cigalikes. Medium devices consisted of vapor pens. Large devices contained re-fillable tanks and included "box mods"

Patient and Public Involvement

Research questions were informed by feedback from prior qualitative studies conducted with the target population of young adult tobacco users.(16) Participants were not directly involved in the study design, recruitment, and conduct of the study.

RESULTS

Many perceived benefits of pod devices were consistent with previous findings on e-cigarettes.(13, 16-19) Participants noted pleasurable sensory experiences, including good taste and smell, a quickly dissipating scent unlike cigarettes, and less noticeable throat irritation than

from cigarettes.(18) For example, Sarah used her JUUL because "just, generally, it smells nice; it tastes good." Khaled preferred non-pod e-cigarettes to cigarettes because of the sweet flavor.

Also consistent with perceptions of non-pod e-cigarettes, pod devices were considered less harmful to health than cigarettes.(16) Adam started using a non-pod e-cigarette because he considers them to be better for his long-term lung health and short-term comfort:

> *"There's no chest pain, like my throat is not kind of itching, dry all time, and kind of like hurting."*

Similarly, Ben noted that JUUL hurts his throat less than do cigarettes, Brandon considered JUUL to be better for his "lung capacity," and William believed that the device is "less harmful than literally everything else." Participants distinguished between "real" smoke and "vapor," expressing that the latter was most likely better for their health. This was true even for participants who had not smoked cigarettes regularly prior to pod device use.

Participants' accounts of pod devices differed from those of other non-pod e-cigarettes in several notable ways. These included the unique ***aesthetic appeal*** of pod devices, ability to ***deliver nicotine*** at high concentrations, and the ***convenience*** of using them quickly and discreetly. ***Contexts of use*** and ***social meanings*** also appeared to differ from non-pod e-cigarettes.

Aesthetic Appeal

Pod devices resemble personal electronics, and charge via USB cable. Participants described them as "sleek" (Brian) and "elegant looking" (James). Some participants who used pod devices compared the shape to that of a flash-drive:

> *"Pick up a pen. You know like this USB flash-drive? It's like one of those but only a little bit smaller."* (Brandon)

These devices can also be charged on a computer, reinforcing associations with electronic devices. One participant described how pod device use was linked to his friend's computer use:

> *"If I'm at his house and we're just sitting on the couch watching something, he's always got his computer out, and [the My Von Erl] charges in a little connector thing. And you can just pick it up and then do it*." (James)

Compared to modifiable e-cigarette 'box mods,' pod devices are smaller and more 'user friendly'. One participant described the appeal of pod devices' simple design:

> *"I did pick up something called a My Von Erl, which is smaller than this tape recorder. […] It's like little pods […]. And you stick it in. And, like, it's really simple."* (David)

In contrast, Michael found it difficult to bring his box mod with him when going out in the evening, noting that "it's a really big thing to carry around, you know?"

Lastly, one participant's experience trying JUUL seemed to reflect new technology early adoption; it was exciting at first, but this novelty wore off:

> *"I mean honestly, it's like a new car. You know, first few years are great. It's a newer car than most others. I'm talking a brand new car. Like you get it right off the lot. It's got like ten miles on it, right? And then a few years later, it's not new anymore. It's not interesting. […] [I]t kind of loses its value as being new and fun and exciting."* (William)

Nicotine Delivery

Although My Von Erl pods were sold in four different nicotine levels at the time of data collection (0 mg/mL, 9mg/mL, 18mg/mL and 36 mg/mL), JUUL pods were available only in 59 mg/ml per pod.(20) Discussion of nicotine content for My Von Erl was limited. Participants using JUUL for more than a month (Brandon, Sarah, Brian), noted JUUL's high concentration of nicotine. Brian described JUUL's standardized pods as "ridiculously strong." This was a marked departure from his box mod, which was "all about the clouds and less about, like, actually getting that buzz." Brandon started his description of JUUL with the observation, "It's like a lot of nicotine, from what I understand."

In addition to identifying JUUL's nicotine content, participants also described physical sensations likely attributable to nicotine delivery. One participant (William) described the JUUL sensation as "a minute of just complete relaxation." Others described triggers for JUUL similar to smoking triggers, such as following meals (Sarah) or after exercise (Brandon). A few participants experienced reduced cravings for nicotine (Liam). Sarah described a reduced desire to smoke cigarettes after daily use of JUUL: "Like the less you're using cigarettes, the less appealing they become to you."

This similarity to cigarettes in terms of sensation and nicotine delivery was something that Ajay said was missing from his 'vape pen'. During an attempt to switch from cigarettes to his friend's vape pen, he found that the vape pen had "just kind of like a little different feel" compared to cigarettes. He credits this difference with preventing him from substituting products entirely, instead leading him to dual use of both cigarettes and a vape pen.

While some pod device users seemed to seek nicotine, others were concerned about addiction. Given JUUL's single nicotine concentration, some participants found it difficult to taper or

reduce their nicotine intake, a strategy favored by Brian during past cessation attempts with a box mod:

> *"I don't want to be addicted to [nicotine], and the best way to quit would be - or the best way for me to quit would be to control it. And to control it, I think it's a lot easier with an e-cigarette that isn't the JUUL. The JUUL you can't control shit, but the, like, box mod you actually can."* (Brian)

A tapering strategy was also preferred by two participants who used non-pod e-cigarettes. Luis enjoyed being able to control how much nicotine was in his box mod liquid. Josh had "drawn back" from 12 mg / ml to 6 mg / ml in his box mod, because he no longer felt like he needed as much nicotine.

Some pod device users were confident in their ability to avoid dependence by imposing limits on use. For example, William reported using JUUL in the morning to "get the most effect", which might be analogous to smoking shortly after waking, an indicator of nicotine addiction.(21) Nevertheless, he considered himself to be at low-risk for addiction:

> *"You know, the only part of it is [sic] that is concerning is the nicotine usage and I'm very, very responsible. So, I didn't really see myself getting addicted needless to say."* (William)

The nicotine level in pod devices appeared to influence the frequency and duration of participants' use in everyday life. Sarah reported taking fewer puffs at a time when using her JUUL (puffs per session) than she does with cigarettes. However, she said that she uses her JUUL at more points throughout the day (sessions per day):

> *"But when I have the JUUL, it's honestly - each hit is a lot stronger, so it's like I'm going to be sitting there for like ten seconds and using it. […] But then I'm going to want to use*

it again, because I didn't get the whole same amount of nicotine [as compared to a cigarette].” (Sarah)

Brian also took fewer puffs at a time when using his JUUL than with his box mod:

“*[I]t's just, like, I would die if I used it all day. I don't feel the need to, like, constantly be hitting it if I have it on me.*” (Brian)

In contrast, David noted that use of non-pod e-cigarettes can differ significantly from person to person:

“I know people who, you know, like, will hit their vape once. And I know people who don’t breathe oxygen, right? Like, they only use their vape.”

Most participants reported that they typically used their pod device for fewer than 3 minutes at a time, with some taking up to a dozen hits over several minutes, and others taking several consecutive hits in under a minute. These variations in use resulted in most participants gauging use by how long a cartridge lasted, varying from 4-5 days (light use) to 1 day (heavy use).

In comparison, use patterns of non-pod e-cigarettes were more difficult for participants to quantify. Compared to cigarettes, Khaled says that use of his box mod is “harder to gauge”:

“I think it takes me a little longer [than with a cigarette], more puffs maybe until I’m like, ‘Okay, I’m satisfied. I’ll put this thing down now.’”

Convenience

Pod devices are small, light and highly portable. The closed pods are tidier than some refillable devices, which can leak e-liquid. When David used a box mod, he found the device to be “troublesome, because, like, the juice can get places.” He also frequently had to replace broken parts. Compared to non-pod e-cigarettes, he considered pod devices to be more “pocketable.”

Pod devices also produce smaller aerosol clouds, allowing discreet use in public places. Liam's decision to switch from a box mod to a My Von Erl was partially motivated by a desire to be "as discreet as possible":

> *"So, ultimately, [the box mod] was just, like, too bulky. It was, like - it's a really big - like, a really big device. And so, yeah, just it wasn't easy to carry around, and it just, like, the smoke output or the vapor output was just, like - just too, too much, just a little too crazy."* (Liam)

Other participants liked the idea of discretion, even if they did not take advantage of this feature. Brandon noted that JUUL could be used discreetly "if you needed to." In contrast, lack of discretion was a significant concern for participants who used non-pod devices. As Esther explained of her box mod:

> *"I don't want to be in public smoking these huge vapor clouds, but I know that I am going to get nicotine cravings."* (Esther)

Ben reported his friends had concealed their use of JUUL on airplanes. The speedy and intense nicotine delivery of JUUL (noted above), facilitated taking a quick "hit" between activities (Sarah), enabling integration of pod device use more conveniently into the flow of the day.

Contexts of Use

Participants described using pod devices in places and situations similar to other e-cigarettes,(13, 22, 23) such as indoors at home and in cars, while relaxing with friends, after eating, and on breaks from work. Compared to cigarettes, both non-pod and pod e-cigarette devices are easy to

use indoors, as they are not perceived to leave a "lingering smell". As Victoria, who uses a vape pen, explained:

> *"You know if somebody has smoked a cigarette in a house. You know if it's been in a car. Even if it's been a while, there's that lingering smell. This [vape pen], it doesn't smell at all."*

The absence of a tell-tale odor allowed Esther to use her box mod indoors without worrying about her landlord's no-smoking policy, and let Khaled feel safe in the knowledge that "it's not going to piss roommates off." Similarly, participants who used pod devices enjoyed doing so indoors. James used his friend's My Von Erl when relaxing on his couch. Brandon preferred JUUL to cigarettes, in part because "you can pretty much do it inside. And it's not like you'll smell up a room with tobacco -- with like traditional tobacco smell." They also noted minimizing use around adults and strangers. However, there were some indications that pod devices may be informally permissible in spaces where tobacco use is prohibited. This may be due to the small device size and minimal aerosol cloud. For example, unlike smoking, Sarah was allowed to use her JUUL indoors at her catering job even when she was not on break:

> *"I usually just have my JUUL on hand, and if I'm ever in a behind-the-scenes setting, I'm allowed to just use that. So I'll just continuously use that throughout my work shift."* (Sarah)

Social Meanings

Pod devices appear to share many of the same social meanings as other e-cigarettes, especially when contrasted to cigarettes. Social meanings here refer to broader understandings of the social

significance of using e-cigarettes, including social acceptability.(24) Compared to cigarettes, both non-pod and pod devices are seen as more acceptable to use in most social contexts. This is likely related to participants' perceptions that they produce a more pleasant smell and are less harmful to health. Luis, who uses a box mod, indicated that people are "less bothered by vaping, because the smell isn't the cigarette smell." John explained that he is less worried about generating secondhand smoke with his non-pod e-cigarette than with cigarettes:

> *"I take into consideration when I smoke because I don't want to affect others' health. So, pretty much in public areas where there tends to be a lot of children, I don't smoke [cigarettes]. Whereas, with the vaporizer, I feel like I'm able to smoke [vape] anywhere."*

However, some participant accounts demonstrated that pod devices may have instigated a shift in the social meanings associated with using e-cigarettes towards even greater acceptability. While large box mods can evoke stereotypes of ostentation or disrespect,(13) pod devices may not be subject to this stigma. Ajay, who uses a vape pen and occasionally a box mod, provided a vivid description of the social disapprobation associated with using non-pod e-cigarettes:

> *"Like two years ago if you were out vaping we would just make fun of you the whole time we were smoking. And we'd just call you like you little sissy. Just smoke real cigarettes."*

James, who used pod devices, voiced similar criticisms of large box mods, calling them "pretty weird" and "kind of lame." In comparison, pod devices are "just really well accepted" among his friends. Brian contrasts the obnoxiously performative connotation of non-pod e-cigarettes with use of pod devices:

"[S]o I went and bought an e-cigarette, and then I felt really awkward using e-cigarettes 'cause they're douchey, and so I got a JUUL because JUULs, for some reason, aren't douchey." (Brian)

The proliferation of pod devices throughout participants' social networks further highlights social acceptability. Most participants reported commonly sharing and using with friends. By the time Brandon first tried JUUL, half of his friends had already purchased their own device. Sarah and her best friend purchased JUULs at the same time, intending to switch to JUUL from cigarettes together.

DISCUSSION

This paper is the first to report on young adults' perceptions and uses of pod devices as compared to non-pod e-cigarettes in a way that may explain their popularity. We found that pod devices share many similarities with other e-cigarettes, including their desirable taste, smell, and perceived health benefits.(16-19, 22) However, several distinguishing features were also evident. Participants enjoyed the 'tech appeal' aesthetic and associated pod devices with user-friendly personal electronics.(9) JUUL pods were perceived to deliver a high dose of nicotine, enabling shorter consumption sessions. Pod devices' portability and discreet clouds made them particularly convenient. These characteristics appear to lend pod devices to inconspicuous use in a wide variety of formally prohibited tobacco use contexts, including in rental units and at workplaces. Finally, pod devices may have begun to reduce the social stigma previously associated with large 'box mod' devices.

Some characteristics of pod devices may help explain their appeal to younger populations. Associations with friendly and ubiquitous personal electronic devices rather than deadly and stigmatized tobacco products may facilitate use by young people, including nonsmokers. These characteristics, paired with social media advertising, may encourage uptake among the young, particularly as social media content facilitates modeling and normalizes use.(3, 4) A systematic review of JUUL marketing content from 2015-2018 on Twitter, Instagram, and YouTube(4) revealed an innovative, engaging, and wide-reaching campaign conducted by JUUL and its affiliated marketers on these social media platforms, with audiences that disproportionately consist of youth and young adults.

Use of pod devices by youth and nonsmokers is particularly concerning as many participants readily spoke of strong nicotine delivery. Descriptions of situational triggers and early morning use suggests a risk of developing (perhaps unrecognized) nicotine dependence. Education about signs of nicotine addiction may also deter experimentation or motivate users to quit. Removal of flavors, offering reduced nicotine strength pods, restricting advertising in youth media channels, and limits on distribution of pod devices might reduce uptake by youth and nonsmokers. On the other hand, powerful nicotine delivery may facilitate pod devices' substitution for cigarettes, and some pod users spoke of decreased cigarette craving. The efficacy of pod devices for smoking cessation should be examined in randomized clinical trials; none have been published to date.

These findings also suggest several strategies for future research. Discrepancies between e-cigarette prevalence and sales,(4) suggest that pod device may be inadequately captured on existing surveillance instruments perhaps due to distinct appearance, brands, and terminology for use (e.g., 'JUULing').(3) As the number and variety of nicotine products proliferate, measures to capture total nicotine intake and dependence need to be developed and should include novel

nicotine delivery devices. Pod device use patterns and experiences should be examined separately from other non-pod e-cigarettes. Triangulating market research and epidemiological surveillance data may better characterize novel product uptake by different audiences; surveillance measures need to evolve as quickly as the e-cigarette market.

Limitations

This study did not specifically recruit pod device users, so the number of pod device using participants was small. Our pod device using participants were predominantly male. They could also be considered early adopters of pod devices, having begun use within the first two years after these products appeared on the market. The experiences of other young adults, particularly women and those who may be less prone to early adoption of new technology, may differ from the accounts presented here. However, pod using participants were able to provide rich descriptions of their products and how they used them. The accounts provided here reflect early 2017 pod devices, and do not include planned changes in the nicotine strengths in JUUL pods(25) or newer refillable pod devices.(26) Further, our analysis did not differentiate between young adults who were using pod devices as a cigarette cessation aid and those who were never established smokers. Finally, this cross sectional analysis cannot determine whether participants progressed to cigarette use or were successful in sustaining a smoking cessation attempt. The differences in uses and perceptions between young adults using pod devices to quit smoking with those who had never smoked prior to pod device initiation should be examined in future.

CONCLUSION

The tobacco product landscape is rapidly changing. Pod devices appear to have catalyzed a shift in how many young adults perceive and use tobacco and nicotine. Pod devices' associations with personal electronics, efficient nicotine delivery, appealing flavor and odor, convenience, and greater social acceptance encourages uptake and use by young adults. As companies promoting new e-cigarette devices replicate these product features and utilize youth media for promotion, these devices are likely to continue to be rapidly adopted by young people. Limits on advertising, availability, and abuse liability of pod devices, and public education to counter industry messages normalizing nicotine use may counteract these trends.

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Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

Developed from:
Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

No. Item	Guide questions/description	Page / line number
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group?	1 / 38-41
2. Credentials	What were the researcher's credentials? E.g. PhD, MD	1 / 4, 9, 14
3. Occupation	What was their occupation at the time of the study?	1 / 6, 11, 16
4. Gender	Was the researcher male or female?	N/A
5. Experience and training	What experience or training did the researcher have?	N/A
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	9 / 4-5
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	9 / 4-5
8. Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	6 / 9-11
Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	7 / 6-22
Participant selection		
10. Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	3 / 7-8 4 / 11-12
11. Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email	6 / 18-19
12. Sample size	How many participants were in the study?	8 / 4-7
13. Non-participation	How many people refused to participate or dropped out? Reasons?	N/A
Setting		
14. Setting of data	Where was the data collected? e.g. home,	6 / 22-23

collection	clinic, workplace	
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	6 / 22-23
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	8 / 4-15 Table 1
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	6 / 22
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	N/A
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	6 / 23
20. Field notes	Were field notes made during and/or after the interview or focus group?	7 / 7-9
21. Duration	What was the duration of the interviews or focus group?	6 / 22
22. Data saturation	Was data saturation discussed?	6 / 15 7 / 20-21
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	N/A
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	7 / 11-12
25. Description of the coding tree	Did authors provide a description of the coding tree?	7 / 6, 13-15, 21-22 8 / 1-2
26. Derivation of themes	Were themes identified in advance or derived from the data?	7 / 6-22
27. Software	What software, if applicable, was used to manage the data?	N/A
28. Participant checking	Did participants provide feedback on the findings?	N/A
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Page 10-18
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Page 10-18
31. Clarity of major themes	Were major themes clearly presented in the findings?	10 / 2-20
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	13 /15-21 15 / 13-18