Menopausal Voice-Related Work Limitation Scale (MenoVWL): Development and Validation

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Summary: Objectives. Menopause has been reported to affect the voice of female professional voice users (FPVUs). The present study aims at the development and validation of a scale to measure self-perceived menopausal voice-related limitation to work in FPVUs, henceforth the *Menopausal Voice-Related Work Limitation Scale (MenoVWL)*.

Methods. Items were drawn from previous studies on impacts of sex steroid hormones on voice, available validated scales, and in-depth interviews with post-menopausal FPVUs. A preliminary version with 16 items was evaluated by a panel of 15 voice experts. The resulting revised version was filled in online, together with questions on current endocrinological reproductive status and related symptoms, history of amenorrhea, professional occupation, and demographic information. Responses concerning only professional voice users were selected and inclusive and exclusive criteria were applied for correct allocation of participants into pre- and post-menopausal stages within a restrict age range;192 responses were subject to factorial analysis for MenoVWL validation. Cronbach's alpha measured internal reliability. The scale was tested by comparing MenoVWL scores between pre- and post-menopausal FPVUs (98 and 94, respectively).

Results. Thirteen items were retained from the expert panel evaluation. Items presented a high Content Validity Index (.94 out of 1) and high Item Acceptance Ratio (86.25 %). Both exploratory and confirmatory factorial analysis rendered one dimension scale with an excellent internal consistency (Cronbach's alpha = .9). The results of a Mann-Whitney test showed a higher MenoVWL score for post- as compared to pre-menopausal FPVUs (Z = - 2.818; P = .005).

Conclusions. MenoVWL is a comprehensive and validated scale with a known factor structure. It constitutes a health care and safety outcome self-perceived measure of value to the early detection of voice-related limitations to work in FPVUs during menopause.

Key words: Menopause−Female professional voice users−Occupational voice-related limitation to work.

INTRODUCTION

Limitations to occupational use of the voice tend to affect females in a larger scale as compared to males.[1,2] For example, the prevalence of vocal nodules - a vocal fold tissue reaction to repeated exposure to phonotrauma [3] - is considerably greater in females than in males (95% as compared to 5%, respectively).[4] Possible explanations include sex-specific morphological, physiological and reproductive endocrinological characteristics.[2] The latter is of particular interest for the current research.

Female voices are highly sensitivity to variations in concentrations of sex steroid hormones (i.e., estrogens, progesterone, and testosterone). Besides puberty, the female voice changes with variations in concentrations of sex hormones across the menstrual cycle, during pregnancy and at menopause.[5] In the latter case, corresponding to the end of female's reproductive life, concentrations of sex steroid hormones fall significantly, and this seems to be associated with a drop in mean fundamental frequency (f_o). A decrease in f_o of about .94 semitones (ST) in speech and of 1.8 ST in the sustained vowel /a/ was found for post- as compared to pre-menopausal females.[6] To those females who use their voices as a tool-of-trade, henceforth, female professional voice users (FPVUs), this drop in f_o, even if small, might not be trifling.[7]

Professional voice users, i.e., singers, actors, broadcasters, teachers, university lecturers, sport coaches, salespersons, lawyers, politicians, clerical workers, counsellors, health care professionals, and factory and call centers workers, all require prolonged voice use.[8,9] From a physiological point of view, this corresponds to frequent collisions of the vocal folds. The rapid vibrations of the vocal folds and the impact stress caused by their contact forces, both contribute for a high exposure of the mucosal tissue to trauma.[10] In the case of being a FPVU, the risk of phonotrauma caused by excessive voicing is even greater, as corroborated by the higher number of female professionals who experience a voice disorder.[1,2]

Notwithstanding the significant representation of professional voice users amongst the working population,[8] and the higher exposure of females to occupational voice-related

health and safety risks,[3] our investigation failed to find validated scales addressing work limitation in FPVUs. Work ability is affected by factors concerning aspects related to health, functional capacity, expertise, values and attitudes.[11] Several validated self-perceived questionnaires to quantify ability to work can be found in the literature.[12] For example, the *Work Ability Index* (WAI) is used to measure work ability during health examinations. It includes questions that assess the physical and mental demands of work, and the worker's health status and resources. This index has been used to promote an early identification of workers who require specific work-related health support.[13] Other available questionnaires are majority focused on impacts of job performance and productivity on company losses. For example, the *Work Limitations Questionnaire* (WLQ) measures how chronic health problems and/or their treatment affect on-the-job work limitations.[14] The *Stanford Presenteeism Scale* (SPS) measures work limitations by assessing worker's knowledge and productivity.[15] Despite evidence of voice limitations in FPVUs at menopause,[16−20] validated scales accessing the degree of which these limitations may affect work ability were also not found.

It is known that menopause can inflict self-perceived difficulties at work.[21] First, females feel unsatisfied with the way they are treated by their employers/managers.[22] Second, females perceive less ability to work due to menopausal-related symptoms, especially vasomotor ones.[21] Third, FPVUs, such as singers and teachers, experience a decrease in vocal range, endurance and vocal fold mobility during menopause, which impact on self-perceptions of vocal quality.[16,20]

The current investigation presents the development and validation of a scale that aims at measuring self-perceived voice-related limitation to work in menopausal FPVUs, henceforth the *Menopausal Voice-Related Work Limitation Scale* (*MenoVWL*). This scale was designed to measure the extent to which menopause may limit perceptions of job performance in terms of occupational voice use and vocal demand, but also with respect to impacts on professional self-concept and self-expectations. Attitudes and self-evaluation beliefs concerning work activities, self-accomplishment in professional environments and organization-based self-esteem, all negatively correlate with depression and aggravation of physical symptoms.[23] Menopause is associated with both depression and aggravation of physical symptoms, which will impact on job satisfaction, organizational skills, affective commitment, and job involvement.[24] Given the increasing number of menopausal FPVUs, it seems important to create such scale, aiming at an early identification of those who seek specific work-related health support.

MATERIALS AND METHODS

Development of the MenoVWL

Items of the *MenoVWL* were drawn from previous investigations on the effects of variations in concentrations of sex steroid hormones on the female voice, especially with respect to menopause.[6,16,17,25−30] Also, responses from previous in-depth semi-structured interviews with post-menopausal FPVUs were taken into account. These included the opinions and perceptions of six elite performers (four internationally touring singers of different musical genres and two actresses with international careers) and two school teachers of different nationalities, with respect to the impacts of menopause on: (1) quality of life and general wellbeing; (2) voice quality; (3) voice efficacy; (4) attitudes towards performance; (5) impacts on their working conditions and career management; and (6) self-identity. The results suggested that menopausal symptoms most affecting their careers were vasomotor disturbances, irritability and anxiety. Voice quality and efficacy were reported to be affected by changes in timbre and f_o, vocal dryness, diminished vocal stamina and increased vocal fatigue. Consequently, their attitudes towards performance changed, namely the need to prepare more extensively for a performance, warm-up before work and make modifications to their vocal technique. In the case of singers, the choice of different repertoire was also referred as a copying strategy to changes observed during menopause. There were also reports of temporarily cancellations of public engagements, and fear of becoming underpaid or unemployed because of disturbances in working schedules and recordings caused by menopausal symptoms. An increase in self-awareness was mentioned, together with the sense of loss of femineity and ageing. These perceptions were reported as potentially increasing anxiety and apprehension.[31] Finally, pre-existing voice-related self-reported measures were also scrutinized for items concerning healthy voice function, voice disability, dysphonia and/ or handicap, voice-related self-efficacy, and ability to work and to communicate.[32] The combination of the outcomes of these three different sources resulted in a preliminary scale's version. It included a total of 16 items, designed using common words with simple grammatical constructs to ensure cognitive accessibility.

The content validity of this first preliminary version was evaluated by a panel of female voice experts: laryngologists, speech and language pathologists, singers and voice teachers. They were all recruited through authors' personal contacts in different countries, including Australia, Brazil, Sweden, UK and USA. From the 23 initially contacted experts, a total of 15 volunteered to participate. Evaluators were requested to rate, in a 4-point Likert scale, adequacy and clarity of all items with respect to construct, i.e., voice-related limitation to work with respect to female sex-steroid hormones at reproductive and non-reproductive stages. Terms such as pre- and post-menopause were avoided to ensure that responses corresponded to true opinions, and minimize socially desirable responses concerning effects of menopause.[33] A 4-point Likert scale was used because a scale with an odd number tends to provide neutral answers.[34] For each item, *Content Validity Index* was calculated by the proportion of experts' responses, rated with 3 and 4 points for both adequacy and clarity. Evaluators were

also asked to indicate the appropriateness of item's inclusion using a 'yes/no' option. This was made to allow later calculation of *Item Acceptance Ratio*. The suitability of the overall length of the scale was also measured by a 'yes/no' question. Finally, suggestions on each item's drafting were encouraged.

Participants and procedures

Ethical approval was obtained from the Ethical Committee of the National Distance Learning University (UNED) in Madrid, Spain. Participants were recruited: (1) through authors' pre-existing personal contacts; (2) via electronic mailing lists, collected by the authors from previous activities on advertising international symposia and continuing education courses on voice science and pedagogy; (3) social networks, such as Facebook groups dedicated to voice science and pedagogy, and Instagram and Twitter accounts; (4) via the designated website of the Voice, Music and Language Laboratory (www.unedvoicelab.com); and (5) word-of-mouth. Participants were asked to fill in an online questionnaire, made available through a *Google Forms* link (Google, Mountain View, California). The questionnaire was open to all female professional voice users who were English speakers, aged 18 or over, with no medically diagnosed hearing impairments and no restrictions to understand nor give an informed consent. Such broad range of females was included to guarantee that responses corresponded to true feelings and not to socially desirable opinions concerning effects of menopause.[33] Thus, instruction to participants was: 'This questionnaire aims at evaluating female's voice-related limitation to work in relation to current stage of endocrinological reproductive life'. Participants were asked to select the option that best reflected the degree of their agreement to the presented statements using a 6-point Likert scale (one, totally disagree; six, totally agree).

In the present study, professional voice users were defined following a four-level scale based on amount of voice use and vocal demand required for a given profession.[35] According to this classification, level I professional voice users are those to whom even slight vocal difficulties may impair ability to work. In this level, one may include classical singers, singers from other genres, actors and radio/ TV broadcasters. Level II embraces professionals to whom moderate vocal difficulties may prevent adequate job performance, such as teachers, public speakers, politicians, call center workers, clerical workers, salespeople, judges and lawyers. Those professionals to whom severe dysphonia impairs ability to work fall into level III, e.g., counsellors, psychologists, receptionists, public relation specialists, phone operators, and speech and language pathologists. Finally, level IV includes all professionals whose work is not compromised even in the presence of severe vocal difficulties.

Data collection was carried out from the beginning of November 2020 until middle January 2021. Besides MenoVWL items, the online questionnaire included questions on: (1) current endocrinological reproductive status; (2) professional occupation, namely type of professional occupation and experience; and (3) demographic information, including age, educational level, professional experience, and life-style habits. These questions were included to ensure correct selection of cases that corresponded to pre- and post-menopausal stages of females belonging to a restrict age group. Such selection was needed for several reasons. First, menopause can only be determined retrospectively; it is defined as the day when 12 consecutive months of amenorrhea occur.[36] Second, the rate of reduction of ovarian oocytes does not occur at a constant rate in all females.[36−38] Thus, age of menopause is quite varied, depending on individual biological and social-demographic characteristics. Third, age is a weak stand-alone predictor of menopause. Fourth, ageing may act as a confounding factor for the sole investigation of menopausal symptoms, so comparisons between middle-age with younger and post-menopausal females within a restrict age range are recommend.[39] However, middle-age females (in their 40s) have lower voices when compared to younger females (in their 20s). Thus, when investigating FPVUs menopausal voice-related symptoms, responses from females with 39 or less years of age were disregarded.

To overcome the challenges of possible confounding factors in the sole study of perceived menopausal-related symptoms, we have followed the 2001 *Stages of Reproductive Aging Workshop* (STRAW) recommendations, which propose a combination of menstrual and qualitative hormonal criteria to define a staging system for ovarian aging. In this staging system (summarized in Figure 1), menopause is used as a guide for setting all other stages, and it is therefore considered stage 0. The reproductive phase includes stages −5 to −3. Stages −2 to −1 correspond to early and late peri-menopause, whereas stages +1 to +2 represent early and late post-menopause.[38,40]

Analysis of validity and reliability

For the purposes of validation of MenoVWL, we followed the recommendations explained above for the sole investigation of menopausal voice-related symptoms. Thus, only responses from participants at stages -3 to +2 of STRAW belonging to a restrict age range (40 to 65 years old) were considered.[37−39] In summary, respondents were selected by applying a combination of the following criteria: for the exclusive criteria - (1) to have ≤ 39 or ≥ 66 years old; (2) to be pregnant; (3) to have an endocrinological problem (e.g., ovarian cancer, polycystic ovarian syndrome, endometriosis, hyper/hypothyroidism); (4) to be using hormonal contraceptive medication; and (5) to be using hormonal replacement therapy; for the inclusive criteria - (1) for stages -3 to -1 of the STRAW menopausal staging system, FPVUs who were experiencing regular menstrual cycles or, if menstrual cycles were irregular, episodes of amenorrhea no longer than three consecutive months; and (2) for stages 0 to +2, FPVUs currently experiencing twelve or more months

FIGURE 1. *Stages of Reproductive Aging Workshop* (STRAW) system. *Stages most likely related to vasomotor symptoms.[37]

of amenorrhea (i.e., absence of menses), without surpassing 5 consecutive years.

Internal validity was analyzed by means of a two-step factorial validation analysis. First, to identify latent variables, an exploratory factorial analysis was carried out on a randomly selected part of the sample. Second, a confirmatory factorial analysis was used to proof the initial structure by means of a structural equation model, using the second half of the sample. This procedure tested model fitting to the data by using the following fit indices: (1) χ^2/df; (2) the *Comparative Fit Index* (*CFI*); (3) *Tucker−Lewis Index* (*TLI*); (4) the *Root Mean Square Error Approximation* (*RMSEA*); and (5) the *Standardized Root Mean Square Residual* (*RSMR*). The suggested cut-off values were: (1) $1 < \chi^2$/df < 3; (2) *CFI* $> .90$; (3) *TLI* $> .90$; (4) *RMSEA* $< .06$; and (5) *RSMR* $< .08$.[41,42] Once latent variables were defined, a reliability analysis was carried out by means of Cronbach's alpha.

Testing the scale: group comparisons

In order to test the scale, MenoVWL scores were compared between pre- and post-menopausal females. Females who have not experienced menopause, i.e., the pre-menopausal group, where those who, according to STRAW menopausal staging system, fell into stages -3 to -1; females who have already experienced menopause, thus referred to as post-menopausal group, where those included in stages 0 to +2. The results of the Kolmogorov-Smirnov test suggested that data were not normally distributed ($P < .05$). Thus, group comparisons were carried out using a *Mann-Whitney* test. Effect sizes were estimated using the Rosenthal's formula and using the following reference values: $r = .5$ (large effect); $r = .3$ (medium effect); and $r = .1$ (small effect). All computations were performed using SPSS version 24 for Windows (IBM Corporation, Armonk, NY) and AMOS.[43]

RESULTS

Sample characteristics

From a total of 682 responses, 165 were disregarded; 16 responses were non-valid and 149 respondents did not fulfil

the inclusive criteria of absence of a medically diagnosed voice problem and current employability as a professional female voice user in levels I to III of the classification system adopted in this study.[35] This yielded a total of 517 valid responses, corresponding to a 75.8 % response rate. However, for the purposes of MenoVWL validation, further inclusive an exclusive criteria needed to be applied, ensuring correct allocation of responses in the STRAW stages that corresponded to pre- and early post-menopause. This yielded a total of 192 responses, 37.1 % of the total valid responses. The characteristics of these respondents are summarized in Table 1, divided into pre- and post-menopausal groups, i.e., stages -3 to -1 and 0 to +2 of the STRAW staging system, respectively.[37,38,40]

Expert evaluation

The combination of expert ratings and their comments resulted in the removal of 3 of the 16 presented items, namely: 'I can be heard while working in noisy environments without people asking me to repeat what I just said'; 'My superiors are sometimes negative about my voice'; and 'I feel I need to improve my vocal training'. These particular items received comments that suggested no rephrasing possibilities to improve their adequacy or clarity. For example, reviewers stated: *I'm not sure what "to improve vocal training" means. Would it be a training with a voice teacher? Or self-vocal health/building regimen? Is it just 'superiors' or all work colleagues? Management implies a more economic perspective. This question may be also leading and can be related to multiple voice issues apart from reproductive life, such as menopause.* The retained 13 items showed a mean item adequacy and a mean item clarity of 3.75 and 3.41 (out of 4), respectively. As to what concerns the overall length, a mean of 3.86 (out of 4) was obtained. The *Content Validity Index* revealed a score of .95 (out of 1) and the *Item Acceptance Ratio* reached a mean value of 87.18 %. All items, except three, were subject to an English language improvement, following the suggestions made by the evaluators for each individual item. Examples of language modifications

TABLE 1.
Participants' Characteristics Whose Responses Were Selected for MenoVWL Validation, Distributed According to Pre- and Post-Menopausal Groups.

Characteristics	Pre-menopausal (n = 98) n (%)	Post-menopausal (n = 94) n (%)	Total (n = 192) n (%)
Age (40-65)			
Mean (SD) yrs.	46.3 (4.2)	57.7 (4.7)	51.9 (7.2)
Educational level			
PhD	22 (11.5)	14 (7.3)	36 (18.8)
Master	48 (25.0)	48 (25.0)	96 (50.0)
Post-secondary degree	23 (12.0)	31 (16.1)	54 (28.1)
No post-secondary degree	5 (2.6)	1 (0.5)	6 (3.1)
Weight			
Underweight	2 (1)	1 (0.5)	3 (1.6)
Normal weight	49 (25.5)	51 (26.6)	100 (52.1)
Overweight	36 (18.8)	35 (18.2)	71 (37)
Obese	11 (5.7)	7 (3.6)	18 (9.4)
Regular physical exercise			
Yes	72 (37.5)	79 (41.1)	151 (78.6)
No	26 (13.5)	15 (7.8)	41 (21.4)
Sleeping quality			
Never/rarely enough sleep	17 (8.8)	17 (8.9)	34 (17.7)
Sometimes enough sleep	15 (7.8)	19 (9.9)	34 (17.7)
Often/very often/always enough sleep	66 (34.4)	58 (30.2)	124 (64.6)
Healthy eating habits			
Never/rarely	11 (5.7)	7 (3.6)	18 (9.4)
Sometimes	13 (6.8)	14 (7.3)	27 (14.1)
Often/very often/always	74 (38.5)	73 (38)	147 (76.5)
Good hydration habits			
Never/rarely	17 (8.9)	22 (11.5)	39 (20.4)
Sometimes	19 (9.9)	26 (13.5)	45 (23.4)
Often/very often/always	62 (32.3)	46 (24)	108 (56.3)
Smoking habits			
One cigarette once a while	6 (3.1)	2 (1)	8 (4.2)
Less than 5 a day	1 (0.5)	1 (0.5)	2 (1)
More than 5 a day	2 (1)	2 (1)	4 (2.1)
No	89 (46.4)	89 (46.4)	178 (92.7)
Medically diagnosed reflux			
Yes, on medication	13 (6.8)	10 (5.2)	23 (12)
Yes, off medication	7 (3.6)	6 (3.6)	13 (6.8)
Yes, in the past	25 (13)	13 (6.8)	38 (19.8)
No	53 (27.6)	65 (33.9)	118 (61.5)
Voice education			
Yes, I currently do	41 (21.4)	33 (17.2)	74 (38.5)
Not now, but I have done it in the past	51 (26.6)	52 (27.1)	103 (53.6)
No, never	6 (3.1)	9 (4.7)	15 (7.8)
Vocal warm-up habits			
Never/Rarely	36 (18.8)	24 (12.5)	60 (31.2)
Sometimes	13 (6.8)	22 (11.5)	35 (18.2)
Often/Very often/always	49 (24.6)	48 (25)	97 (50.5)
Professional voice use			
Level I	23 (12)	13 (6.8)	36 (18.8)
Level II	65 (33.9)	74 (38.5)	139 (72.4)
Level III	10 (5.2)	7 (3.6)	17 (8.9)
professional experience			
Mean (SD) yrs.	20.8 (6.9)	29.8 (9.4)	25.2 (9.4)
Hours/Day of occupational voice use			
More than 8 hours	9 (4.7)	6 (3.1)	15 (7.8)

(*Continued*)

TABLE 1. (*Continued*)

Characteristics	Pre-menopausal (n = 98) n (%)	Post-menopausal (n = 94) n (%)	Total (n = 192) n (%)
Between 5 and 8 hours	43 (22.4)	42 (21.9)	85 (44.3)
Between 1 and 4 hours	43 (22.4)	38 (19.8)	81 (42.2)
Less than 1 hour	3 (1.6)	8 (4.2)	11 (5.7)

include: 'I constantly feel that I am not at my full voice capacity at work', rephrased to 'I cannot use the entire capacity of my voice at work', and 'I have thought of changing my job because of my voice', modified to 'I think about changing my job due to my voice'.

Instrument's validity and reliability

To identify latent variables, an exploratory factorial analysis was carried out with 101 participants, randomly selected from the sample designated for MenoVWL validation (n = 192). The sample adequacy for this analysis was tested by means of the *Kaiser-Mayer-Olkin* statistic, rendering a good adequacy result (*KMO* = .928). The correlation between items was large enough to apply factorial analysis, as shown by *Barlett's sphericity test* ($\chi^2(78)$ = 1091.079, $P < .001$). The 13 retained items from the expert validation were introduced in the exploratory analysis using a *Principal Axis Factor*. After applying the *Kaiser-Guttman* rule, only one factor was found. Factor loadings for all items were > .6 (Table 2). The final factorial solution accounted for 61.7 % of the total variance.

TABLE 2.
Items' Statements and Corresponding Factor Loadings.

Factor loading	Statement
.878	My voice restricts my work activities.
.859	I feel I need fewer hours of work because of my voice.
.849	My voice makes me feel incompetent.
.838	I worry I will lose money as a result of my voice.
.825	I cancel professional engagements because of my voice.
.810	I think about changing my job due to my voice.
.801	My voice affects my decisions about my future career.
.742	I feel pressure at work because of my voice.
.737	I cannot use the entire capacity of my voice at work.
.737	I am underpaid because of my voice.
.707	I cannot get my message across at work because of my voice.
.701	My voice worsens as I work.
.691	My voice reduces the chances of getting professional opportunities.

To test the initial structure, a confirmatory factorial analysis was carried out with the second randomly selected part of the sample for MenoVWL validation (n = 91). The one-factor structure found in the exploratory factorial analysis presented a reasonable adjustment to the collected data. The fit indices obtained were: χ^2/df = 2.89; *CFI* = .824; *TLI* = .789; *RMSEA* = .083; *RSMR* = .093. Finally, *Cronbach's alpha* analysis rendered a reliability of .951.

Testing the scale: group comparisons

To test the final MenoVWL scale (presented as supplementary material to this article), comparisons between pre- and post-menopausal FPVUs were made. To facilitate the interpretation of results as percentiles, the 6-point Likert scale was converted into a 100 point scale. Table 3 displays descriptive statistics for MenoVWL scores for pre- and post-menopausal groups. Overall, mean scores were low, with a percentile of 15.06 for the total sample. For pre- and post-menopausal FPVUs, mean percentiles were 12.21 and 18.04, respectively.

Results of the Mann-Whitney test rendered significant differences. As shown in Figure 2, post-menopausal FPVUs show higher self-perceived voice-related limitation to work as compared with pre-menopausal professionals (Z = - 2.818; P = .005), although the Rosenthal effect-size is low (r = .15). In addition, the number of outliers are greater and widely distributed for post- (between 56.92 and 75.36) as compared to pre-menopausal FPVUs (between 44.62 and 55.38).

DISCUSSION

Female-specific vocal and endocrinological characteristics place FPVUs at a higher risk of developing occupational voice-related hazards as compared to male professional voice users (MPVUs).[2,3,44] At menopause, due to a significant depletion in concentrations of sex steroid hormones, FPVUs may suffer from debilitating symptoms that affect their self-perceived voice-related ability to work.[21] Some may even feel compelled to abandon their workplace,[45] as menopausal voice-related symptoms may contribute to the impairment of FPVUs work ability.[16,20,31,45] The development and validation of a scale that assesses menopause voice-related limitation to work seems therefore crucial.

Following the definition of work ability proposed elsewhere,[11] MenoVWL included questions on self-perceived limitations to work concerning voice-related occupational health, such as 'My voice worsens as I work' and 'I feel I

TABLE 3.
Descriptive Statistics for MenoVWL Percentile Scores, for Pre- and Post-Menopausal Professional Female Voice Users.

Professional Female Voice Users	*M*	*Md*	*SD*	*IQR*
Total sample	15.06	7.69	17.65	16.92
Pre-menopausal professionals	12.21	7.69	15.44	16.92
Post-menopausal professionals	18.04	9.23	19.70	18.46

Abbreviations: M, mean; Md, median; SD, standard deviation; IQR, difference between 75 and 25 quartiles.

need fewer hours of work because of my voice'. It also assessed perceptions of voice-related functional capacity, such as 'I can't use the entire capacity of my voice at work'. In addition, questions on expertise were included, e.g., 'My voice restricts my work activities', as well as questions concerning values, such as 'I am underpaid because of my voice'. Finally, changes in attitudes were also investigated, such as 'My voice affects my decisions about my future career' or 'I cancel professional engagements because of my voice'. MenoVWL also presented questions on employee's self-concept, such as 'My voice makes me feel incompetent' and on self-expectations at work, such as 'My voice reduces the chances of getting professional opportunities'. These questions were included because self-evaluation of perceived work limitation and self-accomplishments in professional environments have been significantly associated with job satisfaction and job commitment. On the other hand, both job satisfaction and commitment have been negatively associated with depression,[46] and depression is one of the most
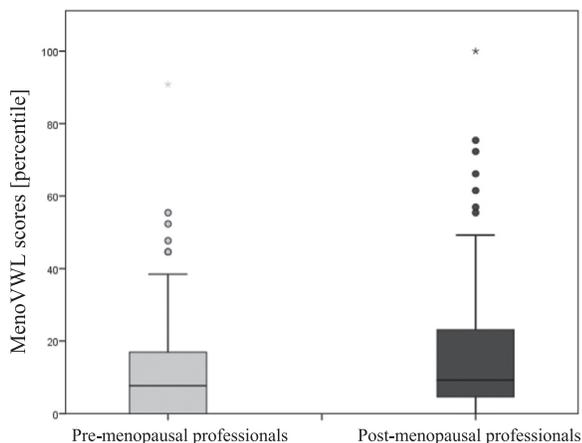

FIGURE 2. MenoVWL percentile scores between pre- and post-menopausal professional voice users. The boxplot represents the part of the distribution that falls between the 25th and the 75th percentiles, the horizontal line crossing the interior of the box represents the median, and the vertical lines outside the box connect the smallest and largest values that are not outliers nor extreme values. Open circles and asterisks represent outliers and extreme values, respectively.

commonly reported menopausal symptom, with a significant contribution to an aggravation of self-perceived limitation to work.[23] These items were important to be included because MenoVWL was designed to assess voice-related work ability rather than perceptions of voice problems during menopause. If the latter would be the aim of the current investigation, other already validated scales, such as the Voice Handicap Index (VHI-30) or the Singing Voice Handicap Index (S-VHI), would be sufficient.[47]

From the initially designed 16 items, only 13 were retained from an expert evaluation. These 13 items were high in adequacy in terms of their construct, and high in clarity (3.75 and 3.41 out of 4, respectively). They also received a high *Content Validity Index* (.94 out of 1) and a high *Item Acceptance Ratio* (86.25 %). The exploratory factorial analysis identified one latent variable, with a sufficiently large correlation between items to apply a factorial analysis. Thus, a confirmatory factorial analysis was carried out to test the scale's structure. The results demonstrated an excellent internal consistency (Cronbach's alpha > .9).

MenoVWL was designed to target FPVUs belonging to the first three levels of professional voice users classification system, based on voice use and vocal demand.[35] For testing this scale, comparisons between pre- and post-menopausal FPVUs were made. The results showed that post-menopausal professionals perceived higher voice-related limitation to work as compared to pre-menopausal professionals. This result was expected, as menopause has been frequently associated with alterations in voice quality and voice function[6,16,18,25,48] that may affect working ability. However, the effect size was small ($r = .15$). This could have resulted from our sample characteristics. The majority of MenoVWL respondents were level II professional voice users, i.e., professionals to whom only moderate vocal difficulties may prevent adequate job performance.[35] This level includes teachers, public speakers, politicians, call center and clerical workers, salespeople, judges and lawyers. Although the over representation of level II professionals in our sample follows the trend reported elsewhere for percentage of U.S. working population,[8] this could have constituted a limitation to our results. Voice education tends to increase awareness of voice use, improving the management of occupational voice-related health and safety.[49] Thus, one may speculate that effect size could have been higher if the sample included a higher number of level I professionals. This level includes professionals to whom even slight vocal difficulties may impair ability to work, such as singers, actors and radio/ TV broadcasters.[35] Future research may consider applying this scale only with level I professional voice users. The results of such study could contribute to a better understanding of whether the onset of menopause requires adjustments in the workload of this specific group of professionals.

Comparisons between pre- and post-menopausal groups showed outliers. These were not excluded from the analysis because severity of menopause-related self-perceived effects varies substantially between individuals.[37] In our study,

menopause seems not to be perceived as a strong limiting factor to work for the majority of FPVUs (mean responses were around 20th percentile); however, there were cases in which menopause lead to serious limitations (around the 80th percentile). One may speculate that, unlike other older females, to whom cognitive strategies protect their self-concept from the influence of body dissatisfaction,[50] FPVUs may lack on coping strategies that can assist in protecting their self-concept from the impacts of dissatisfaction with the characteristics of a changing voice. In a clinical setting, the application of this scale can be of particular relevance as a preventive measure, assisting the development of better health care options, as they will be more sex, age and occupational orientated.

The overall low self-perceived voice-related limitation to work was not a surprising result. Participants in both pre- and post-menopausal groups had comparable characteristics. The majority had healthy life-style behaviors, such as practice of regular physical activity (at least twice a week), good sleeping and eating habits, good hydration levels and the absence of medically diagnosed reflux. These characteristics, if not similarly distributed between groups, could indirectly interfere with our results, acting as confounding factors. In addition, the majority of participants had voice education in the past, and there was a substantial number who were still having voice education. The majority reported to warm-up before work. Also, we had a similar distribution of weight-related characteristics between pre- and post-menopausal groups, with the majority of participants belonging to a normal weight. This further contributed to minimizing possible biases in our results: post-menopausal women with higher BMI have higher levels of estrogen as compared to those with lower BMI. These higher estrogen content seems to impact on acoustical characteristics of the voice, such as f_o.[48]

MenoVWL responses were collected online to facilitate a large dataset.[51] Also, online data collection was a recommended option for conducting research during outbreaks of rapidly evolving infectious diseases, such as the COVID-19 pandemic.[52] However, this approach to data collection could have been a limitation to our study. During COVID-19 pandemic outbreak, FPVUs faced a substantial reduction in their professional activities. Future investigations should compare MenoVWL scores with acoustical, physiological, aerodynamical and perceptual vocal characteristics of pre- and post-menopausal FPVUs in a non-pandemic situation.

Only 37.1 % of the valid responses were considered for MenoVWL validation and testing. Thus, sample size could be insufficient to guarantee the scale's validity. Nevertheless, the scale's length was short (13 items), so 192 responses still allowed for robust factorial analysis.[53] Also, to use all valid responses (n = 517) would offer several methodological drawbacks. First, knowing that the questionnaire was about menopause could lead to 'socially desirable' answers instead of true opinions on menopause-related perceptions.[33,34] To avoid this, the questionnaire needed to be open to FPVUs who were English speakers, aged 18 or over, and participants were instructed to provide their responses based on their 'current endocrinological reproductive stage'. Second, the risk of incorrect allocation of responses into pre- and post-menopausal groups would be greater if the questionnaire would target only women of certain age-range. Age is not a good stand-alone predictor for menopause. Also, menopause can only be determined retrospectively. On the face of these methodological demands, required when studying menopause-related self-perceptions, we have applied a combination of specific exclusive and inclusive criteria, following the STRAW menopausal staging system.[37,38,40] Only participants belonging to stages -3 to -1 and 0 to +2 of the STRAW menopausal staging system, aged between 40 and 65 years old, were included. When testing the scale, participants were divided into pre- (stages -3 to -1) and post-menopausal (stages 0 to +2) groups.

Age at menopause is largely dependent on individual biological and social-demographic characteristics. Thus, age is not a stand-alone criteria for allocating participants into pre- and post-menopausal groups. We have followed the recommendations of the World Health Organization (WHO) to reduce confounding effects of aging when studying the sole impacts of menopause.[39] For comparative study designs, WHO recommends comparisons between three groups with restricted age range: young and middle-age pre-menopausal and post-menopausal women.[39] We only included middle-age pre- and early post-menopausal FPVUs because previous studies have shown that females at their forties have lower voices when compared with females at their twenties.[54,55] The mean age difference between pre- and post-menopausal groups was approximately 10 years. This age range could have acted as a confounding factor in our results. However, a recent meta-analysis suggests that effects of aging on acoustical, physiological and perceptual voice metrics appear later than 65 years old[56]; the mean age of our post-menopausal group was 57.7 years old.

One could argue that another possible limitation of this scale would be that items are non-sex specific. In such case, one would expect the inclusion of age-matched male professional voice users (MPVUs), whose scores could be compared with pre- and post-menopausal FPVUs. However, such study design would not be supported by the evidence provided in the literature. First, differences in health outcomes between females and males should not be solely attributed to biological differences; interactions between elements that shape social reality are equally important.[57] Thus, it is expected that males and females react differently when assessing their exposure and vulnerability to health risks, leading to quite different experiences with respect to illness and healthcare.[58] Second, the depletion in concentrations of sex steroid hormones at the end of a female reproductive life, i.e., menopause, is abrupt. For a male, the same does not apply. The end of reproductive life, i.e., andropause, involves a gradual and much slower decrease of sex steroid hormones over the years, leading to a peak depletion

much later in age (approximately after 70 yrs.).[59] At this point in life, the assessment of MPVUs work ability would not be relevant; the majority would be already retired.

Given the complexity of female's reproductive endocrinological system and the impacts of variations in sex steroid hormones on voice quality, future inclusion of this scale in regular medical evaluations seems a step forward in improving health-care of FPVUs. Bringing sex and gender sensitivity to healthcare practice and education is required to improve decision-making and health-related outcomes.[60] In addition, it would be worthwhile to apply this scale longitudinally, comparing MenoVWL scores for the same FPVUs at different stages of the STRAW menopausal staging system. Such longitudinal studies are scarce, although considered as the golden standard for the understanding of impacts of menopause.[39]

In future work, the use of this scale as an occupational health and safety preventive measure at workplace should also be encouraged. At work, menopause is frequently considered as a taboo topic, implying that it may be embarrassing or inappropriate to discuss.[22] As a consequence, communication between female employees and employers with respect to menopause may be limited, or occur at a later stage to allow for improvements in employers' working conditions. In such scenario, the workplace can be understood as a promoter of anxiety and tension, in which menopausal females are compelled to hide their symptoms.[61] Also, lack of awareness on menopausal-related experiences at work may, by itself, worsen menopausal symptoms.[62] With the present investigation, we hope to contribute to the improvement of occupational health care and safety of the increasing numbers of aging females whose livelihood depends on voice quality.

CONCLUSIONS

MenoVWL is a scale that measures self-perceived menopausal voice-related limitation to work in FPVUs. It includes 13 items that assess menopausal limitation to work concerning voice-related occupational health, functional capacity, expertise, values, attitudes, self-concept, self-expectations, self-evaluation and self-accomplishments. A preliminary test of this scale showed that post-menopausal FPVUs seem to have a higher MenoVWL score when compared to pre-menopausal professionals. Thus, the application of this scale within both clinical and working environments seems worthwhile to pursue, especially if the aim is to develop specific occupational health and safety preventing measures for aging FPVUs. With our aging population, it is expected that increasing numbers of FPVUs will seek to maintain self-perceived voice-related working ability across their chosen careers.

DATA AVAILABILITY STATEMENT

Datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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