Research Article

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Respiratory Muscle Strength Training for Bariatric Patients - A Personal Perspective

Karrie Kuecker*

[1]Resolve Diamondback Post-Acute, Phoenix, USA

***Corresponding author:** Karrie Kuecker, Resolve Diamondback Post-Acute, Phoenix, USA, E-mail: kkuecker@emich.edu

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Abstract

The purpose of this research study is to examine how a respiratory training protocol, consisting of: Respiratory muscle strength training, oropharyngeal exercises and diaphragmatic breathing support training affect the outcomes, both Quality Of Life (QOL) and physiological measures, experienced by morbidly obese bariatric patients who are long-term residents at a skilled nursing facility in Scottsdale, AZ. Osborn Health and Rehabilitation focuses on meeting the short-term and long-term needs of individuals with diverse health needs. However, this facility focuses its long-term rehabilitative care on morbidly obese (Bariatric) patients, with a tailored program of both Physical Therapy and Occupational Therapists trained in the specialized needs of this population. As such, they previously identified a deficit in the program that included breath support training. The Primary Investigator (PI) was tasked with developing a supplemental voice and breath support training program to address their specialized needs. All participants in this research study are current patients of the Osborn Bariatric Program and informed consent was provided by all participants. Data collection occurred *via* survey completed by the participants, followed by a thematic analysis (Guest, Macqueen, & Namely, 2011) performed to identify and code the developing themes for future analysis. A review of the themes generated indicate that the participants placed value on QOL measures more than physiological measures and all identified what they reported as "positive changes" and "improvements" that they attributed to participation in breath support and vocal training treatment.

Keyword: Respiratory Muscle Strength Training (RMST); Bariatric patients; Breath support and voice therapy; Quality of Life (QOL) improvement; Oropharyngeal and diaphragmatic exercises; Physiological and functional outcomes

Introduction

Bariatric patients are an under-researched patient population within healthcare. Their needs are specific to the individual and their concomitant and underlying health care needs vary which makes a large scale, controlled research study difficult. One such need is that of breath support. Severin, et al., identify and discuss the increased respiratory load placed on the respiratory skeletal muscles, reduction in both respiratory muscle strength & endurance, which can contribute to the dyspnea that is so prevalent within this population [1]. There is also a discussion on there being increased presence of inflammation mediations which can cause respiratory muscle weakness by altering the contractile properties of the respiratory muscles and affect diaphragmatic contractility. This indicates the need for specialized interventions for this population, to address these specific needs compared to their 'normal sized' peers.

This study examines 13 participants, all which were receiving occupational, physical and speech therapy as part of the Osborn bariatric program and all participants were actively participating in a breath support/voice treatment program to promote breath support for speech and promote endurance and increased participation in physical and occupational therapy sessions. They were identified by Physical or Occupational Therapy practitioners as having decreased endurance, poor breath support, "getting winded" easily during exertion and reliance on supplemental oxygen or use of a CPAP/BiPAP/Trilogy device to promote airway management. At the time of data collection, all participants were undertaking the program for a minimum of 8 weeks, assigned a Home Exercise Program (HEP) and reported improvements in effort of exertion during RMST training tasks, decrease in carbon dioxide levels and reports of several QOL changes (*e.g.,* ability to sleep on their back without waking up gasping, improved recovery time following exertion, *etc.*). While these QOL measures are important for the participants, they are difficult to quantify numerically.

Questions

This paper strives to answer the questions:

- How has respiratory muscle strength training affected a bariatric patients' overall participation in

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the Osborn Bariatric Program?

a. How do the patients feel that voice and breath support training has helped their overall progress in the program?

- What quality of life (QOL) improvements has the bariatric patients noted that they attribute to the voice and respiratory training portion of the Osborn Bariatric Program?
- What physiological (measurable) improvement has the bariatric patients noted that they attribute to the voice and respiratory training portion of the Osborn Bariatric Program?

a. What concomitant conditions were affected by the voice and respiratory training program *via* patients' self-reports?

Materials and Methods

Data were collected *via* survey and semi-structured interview between the PI and all Prior to data collection, all participants completed a short, demographic survey to determine if they met inclusionary criteria for the study. These inclusionary criteria included: being considered "Bariatric" which is determined as having a BMI >41, having a respiratory diagnosis (OSA, OHS), having a concomitant (secondary) condition to their primary diagnosis of "Morbid Obesity," is a participant in the Osborn Health and Rehab Bariatric Program and having never received speech therapy services for breath support and/or voice therapy prior to beginning this training program. Informed consent was also obtained (written) and the PI addressed any questions or concerns before the semi-structured interview and survey occurred. All participants were educated of the goals of this project prior to participating. The PI generated transcripts of the semi-structured interviews, which were then reviewed by the PI and coded for future analysis. These codes were then reviewed and analyzed in accordance with thematic analysis [2]. These themes were then discussed and used to answer the three research questions.

Results

Thematic analysis revealed that participants identified several 'personal' improvements and several 'program' improvements. 'Personal' improvement theme includes: Improved appearance, reports of being more in tune with their bodies, increased feelings of control over their situation, improved sleep/change in sleeping positioning (supine vs prone) and an overall sense of accomplishment. 'Program' improvements include: Increased ability to perform OT and PT exercises, decreased recovery time, increased ability to complete more complex endurance tasks. While these reported improvements are extremely important to the participants' overall wellbeing, they are difficult to quantify numerically and report through daily treatment notes. From there, further analysis took place, examining specific themes that were noted within the data, including: Physical aspects (of program success), Progress, Recovery time, techniques, integration, calming/coping, sleep, control/in tune with their bodies, vanity, physiological changes and self-reported physiological changes (non-verifiable). These themes directly addressed the research questions that this project strives to answer.

Theme 1: Physical aspects of overall program performance

When asked how the respiratory muscle strength training program affected the participants' overall performance in the Osborn Health and Rehab Bariatric Program, all of the participants identified both general and specific features. One of these is the "physical aspects" of therapy meaning the actual tasks completed during physical and occupational therapy sessions.

P2: Very much! It's gotten better, more tolerance for the physical aspects of therapy.

P4: Walking!

P13: Helped a lot, tied into helping with a lot, not just getting more oxygen, being more alert and not bleh, with PT recover faster, not running out of air and farting as much

All 13 of the participants identified specific aspects of the OHRBP reported that they felt that the breath support training and RMST focused program did benefit their overall progress and performance during their time in the program. These included perceived improvement in walking, increased endurance during PT/OT activities, recovery time between activities and feeling of overall improved tolerance to therapy interventions. One of the participants attempted to describe the multiple aspects of their rehabilitation journey that they felt were improved and found it difficult to fully articulate, but assured the PI that there was, indeed, a difference. However, these aspects are largely 'perceived factors' that can be difficult to empirically quantify. This remains a barrier for treating clinicians as progress with Long-Term Care (LTC) treatment at a Skilled Nursing Facility (SNF) must be able to be synthesized into a numeric score or easily reportable and comprehensible by other clinicians and insurance program reviewers.

Theme 2: Perceived progress

All participants were able to identify an area of

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progress or perceived progress, compared to when they started on the Osborn Health and Rehab Bariatric Program.

P12: Helped me. I would be on my mask all the time or a lung thing. Or be at 10 or 7 (meaning LPM O_2 when prompted).

P2: I do, I can do the program without it; however, with it I progress quicker. I went from bed ridden to going for walks and I've improved off the hoyer!

P10: I'm breathing better and enjoying therapy better. Slowed down with therapy, needing to focus on my breathing, not just rush through.

P3: Hard to say, been on back in bed for about 6 years, now I'm standing & walking & going to the gym.

P1: Progress faster, improved my posture & sitting up more.

Several of the participants stated that they felt it was difficult to accurately report their progress or what progress that they had seen during their experience with therapeutic interventions; however, all were in agreement that progress had occurred and they were pleased with their progress. Overall, both measurable progress and perceived progress lead the participants to feeling that they were able to progress faster and 'do more' during physical and occupational therapy activities. While some of these perceived areas of progress are measurable (*i.e.,* decreased oxygen flowrate that was verified by reviewing orders placed and updated in the participant's medical chart), others (*i.e.,* "progress faster," "breathing better and enjoying therapy better") are harder to fully empirically quantify. This should not diminish the validity of the participant's lived experience and perceived progress in the program.

Theme 3: Recovery time

The most commonly mentioned theme was "Recovery time." 7 of the 13 total participants all verbalized a perceived improvement in recovery time during exertion tasks with physical and occupational therapy tasks. This theme is one of the most important, as all of those participants went on to explain that they felt they were able to overall do more during therapy and expressed hope that it would shorten their overall recovery time and their goals to discharge to a lower level of care with increased independence.

P3: I'm not sure, my recovery time has decreased when working with PT and OT. Recovery time & walking. (Expanded: Less time to recover w/PT/OT & increased distance in walking before needing to rest.

P6: Breathing has improved, recover faster with exercises. I'm not dying & huffing and puffing all the time now.

P12: I think it works together. Like my recovery time is less and it's easier to recover.

P13: Decreased recovery time during PT, breathing better at night and I'm not as fidgety.

Looking at this from the perspective of a rehab clinician, this is a powerful assertation and can directly affect overall outcomes and success with therapeutic interventions. However, as a medical Speech-Language Pathologist in a SNF, there is not always ready access to the notes from other disciplines to determine if this is, indeed, correct. Neither is this easily documented for insurance companies from a breath support or voice treatment perspective. However, it is important to note that though this is overall seen as a "perceived improvement," it needs to be treated as significant, as the participant expressed this as a motivation feature to continue towards meeting their ultimate goal of discharging to a lower level of care.

Theme 4: Techniques

This theme came about by asking the question of what participants felt was the most beneficial part of the voice and breath support program. The participants, however, also reported what parts they "liked," not just what components they felt were the most beneficial.

P2: The deep breathing, I've noticed the most changes in my CO_2 and more progress with PT. Also, the Breathing pipe, it's helped too.

P3: RMST and standing with RMST, I'm not as tired when walking.

P10: The breath support, it's helped with PT and walking.

P4: The RMST device, I feel like my lungs are stronger & expand more. My shallow breathing is better; I'm breathing from here now (points to abdomen).

P7: Trying to remember the breathing exercises during PT, they help with recovery so I can do more.

P13: RMST & standing with RMST. My lungs say "wait a minute, we can do this again! Woohoo!" Not sitting as much.

This theme illustrates the perceived improvement that the participants are reporting and the techniques that they have used to integrate into other portions of the Bariatric Program at Osborn Health and Rehab. Each member of the program completes RMST tasks, RMST while standing/positional, dynamic inhalation/exhalation tasks with variable resistance, Oropharyngeal Exercises (OPEs), use of an OPEP device (Fluttervalve, if requested and provided by their MD/NP) and diaphragmatic breathing tasks designed to promote deep breathing. They are encouraged to use these techniques during PT and OT treatments, to

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address their recovery time and promote appropriate breath support patterns for speech during exertion tasks.

Theme 5: Integration of techniques with PT/OT therapy

During a discussion of the use of techniques and how the voice and breath support training has affected their overall progress in the OBP, the participants all reported that they felt they were able to use the techniques and tools acquired during Speech Therapy sessions during PT and OT treatment sessions. Some of these, are very similar to the above noted themes, in that they mention recovery time or use of specific techniques; however, when asked for clarification, these participants all described the use during treatment sessions and the focus was not on only the recovery time or the techniques.

P4: I don't need Oxygen as much and I can do more with PT & OT without needing a lot of time to recover.

P6: My workouts are better and easier.

P13: Not doing the "dog pant," and easier to catch my breath! When Rhea & I were walking, before I knew it, we were at station one! given me, helped me, blah blah…helped me with breathing in general.

P6: If it wasn't for the breathing stuff, OT & PT wouldn't be what it is.

P13: With breathing – it allowed me to focus more on therapy. 1-2 minutes recovery time versus 5-10 minutes. I'm able to do more than previously.

P8: I've definitely progressed, it's harder than it seems. Progressed with memory and things too.

P4: It's affected how I breath when talking, standing, walking while pushing my wheelchair doing the RMST.

This theme is quite important, being a rehabilitation professional, interprofessional collaboration and cooperation are important to the overall wellbeing and outcomes of our patients. If they are able to apply the techniques and tools trained during therapy sessions into 'real world' scenarios, in this case workouts with physical and/or occupational therapy and see the results, they will hopefully continue to use them and integrate them into their daily routines. Promoting independent carryover of these techniques is also a goal for each of the participants.

Theme 6: Quality of Life (QOL)

The semi-structured interview revealed the participants attitudes regarding Quality of Life (QOL) improvements that had been noted anecdotally by the PI and reported by some of the participants previously. However, three of the following themes (calming/coping, vanity and Control/in tune with body) were not originally considered by the PI and were only revealed through the semi-structured interview that accompanied the survey.

Subtheme 1: Calming/coping

P4: It's helped a lot..lowering my anxiety with the deep breathing.

P1: Yes, it's calmed me down and helped lower my anxiety.

P2: It's given me a coping mechanism when I have difficulties.

P1: I'm definitely thinking better & can figure things out better.

P5: I'm more aware of running out of air while talking now and I prioritize it more. I tend to use the breath exercises more, like when I feel like I can't breathe.

P9: I can breath…relax when they want to get up/stand up and when they transfer me.

P7: It helped a lot, with surroundings (sensitivities) and working through them. I don't cough as much as I used to (scent sensitivity).

P9: Deep breathing, it really calms the body.

P12: Without the tools, I go "sss" or 5-5-5 and stairstep breathing. If my throat is weak, I do this 3 times (demonstrates Masako Maneuver) or if I'm nervous, I'll (does roof scrape)

These QOL indicators are a positive addition to the participants' overall wellness; however, they were not intended outcomes. As such, they are difficult to empirically quantify, document and report other than as anecdotal observations, if reported during therapy sessions. The participants all mentioned that these noted affects from their independent use of the trained interventions were as important to them, if not more so, than the empirically measured outcomes documented throughout Plan of Care (POC).

Theme 6 Quality of Life (QOL) subtheme 2: Sleep

This theme was the only one identified that was expected. There is a wealth of literature examining quantitative and qualitative measures of sleep for Obstructive Sleep Apnea (OSA) and literature on snoring treatment [3-9].

P4: Sleeping better, I don't wake up at night as much. I recover faster with PT so I can walk more and go further before feeling like I'm dying.

P7: Sleeping better, voice is better in the morning, still off in the evening. Overall, definitely seen

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improvement.

P6: I can sleep on my back again! I haven't done that in forever cause I couldn't breathe! I recover faster during workouts.

P8: Yeah, but I'm not really stressed, so I sleep well anyway, but it's helping. Can't say it hasn't, I don't get tired as much.

P9: I'm sleeping better and I don't need as much oxygen.

P2: I sleep better, feel less confused, more aware and alert. I have a more organized sleeping pattern and breathing options. I can use methods to determine issues and know how to address them, when I can't breathe well.

P11: I sleep without a concentrator now!

P12: I breath better, use the routine you taught me when I get woken up… They fixed my machine! I'm sleeping better.

This theme was identified and discussed during the semi-structured interview by the largest number of participants (8 of 13). However, when asked to expand upon how they felt they were "sleeping better," most reported it was difficult to accurately describe, they just 'felt it was better.' It is important to note, not all participants use a CPAP/BiPAP/APAP/AVAPS, nor did all participants use supplemental oxygen during sleep at the time of this study. There have been attempts to empirically represent sleep quality (*e.g.,* PSQI and SQS); however, when the PI attempted to administer these to the participants during assessment, none reported feeling they had any sleep issues. Thus, these sorts of assessments are not included in the assessment or treatment protocols associated with the OBP voice and breath support training program.

Theme 6 Quality of Life (QOL) subtheme 3: Control/in tune with body

This theme was reported by one female and one male participant during the semi-structured interview portion of the study. This theme had not been considered and mention of it was not identified in any of the literature reviewed.

P5: I have a better understanding of my body & breathing and more in control of my body. I'm more at peace. Breathing better and more control over things. I can sing again too.

P5: Overall breathing better and more control during changes.

P5: like the deep breathing (diaphragmatic breathing) exercises the most, it makes things manageable. I'm in control of my health! I don't like the swallowing at all.

P6: I gained a tolerance for holding my breath & controlling my breathing in high pressure situations like standing up.

While this theme was isolated to only 2 of the 13 participants, both of them identified it as being of significance to them. Having spent more than nine years working in an SNF setting, one of the constant things reported by patients anecdotally is loss of autonomy and increased reliance on others. This is also a QOL measure that there is not a good way to empirically quantify to include in an assessment or daily treatment note.

Theme 6 Quality of Life (QOL) subtheme 4: Vanity

This subtheme was also an unexpected surprise that arose during the semi-structured interview. The participant reported his most important improvement was having his oxygen orders changed; however, he did not report it as no longer using oxygen, he reported it as 'not wearing a cannula' and discussed looking in the mirror and his reactions.

P11: Yes, no cannula and no daytime oxygen!

P11: Doing excellent, because I don't wear that cannula on my face any more! It brought me down big time! I never looked in the mirror, now I look in the mirror much times a day!

P11: I sleep better and look better!

P11: I get up in the morning and go to the mirror and see no cannula. I go to therapy and need no oxygen. I roll around in my chair and no one bothers me, you need a tank or your tank is dragging or your cannula is dragging. No more of that!

While this subtheme was only mentioned by 1 patient, it was included four times during the semi-structured interview and included in the survey. This subtheme was surprising and unexpected to me; however, a speech-language pathology student I had at the time of data collection pointed out that this could be related to the "machismo" aspect of this participant's culture, being as he is Latino. This aspect was not considered prior to data collection and could warrant further exploration and consideration during future studies.

Theme 7: Physiological changes

All of the participants identified some manner of physiological changes that they attributed to their participation in the voice and breath support program at Osborn Health and Rehab. Their main focus was on either their oxygen levels or CO_2 levels or some aspect

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related to either of those measures.

P8: my oxygen, I used to be 85-89, but now I'm usually 92-93 when they (the CNAs) test me.

P1: Yes, my Oxygen lowered from 7 to 4! (7 LPM *via* nasal cannula to 4 LPM *via* nasal cannula, continuous)

P2: My CO_2 is lower and my Oxygen lowered from 6 to 4! (6 LPM to 4 LPM).

P3: My Oxygen went from 5 to 2. (5 LPM to 2 LPM *via* nasal cannula PRN)

P4: My oxygen is better, I'm usually always in high 80's to low 90's now, without oxygen! I used to drop a lot more often.

P5: My CO_2 has never been this low in my adult life! They usually can't give me a number! (37 per patient report & CBC report; said it's usually >40 and HH on CBC).

P9: my oxygen orders got changed! I don't need it all day now!

P7: They check my oxygen levels more now, the nurses

P10: My voice isn't as raspy; I don't sound like a man or a smoker

P11: It's been good! I don't need that oxygen any more!

P12: I used to choke all the time, & I know now how to get it up. To use other stuff, like you can't swallow right.

P13: My blood pressure isn't "uber high" any more, the nurse told me that.

These reported improvements are able to be tracked and documented; however, this is usually done by either floor staff (nurse or CNAs) or by Physical Therapy before or during the course of treatment sessions. The participants reporting awareness of these changes also indicates that they are aware to their overall plan of care and that they have a vested interest in their care while at OHR and participating in the OBP. However, while all the participants attributed this change to their participation in the voice and breath support training portion of the OBP with speech therapy, it is important to note that there are a number of factors that could have contributed to these physiological changes and that are not able to be controlled for in the SNF environment.

Theme 7 subtheme 1: Participants' self-reported physiological measures

This subtheme differs from the overall theme of physiological changes by these being self-reported and not necessarily documented in the participants' medical charts, therapy documentation or by a discussion with members of the participants' care team. However, as with several of the themes above, this theme was reported by most of the participants and they reported it as being significant to their overall performance in the OBP.

P1 - Diaphragmatic breathing exercises, they helped expand my lungs & lung capacity

P11 - no cannula and no day time oxygen!

P12 - That helped! My CO_2 has decreased at least half and my pulse has gone down. (per patient's self-report, unable to determine w/a CBC in patient's chart)

P2 - My voice has gotten stronger

P2 - It has, but it's hard to put into words. It's changed my breathing, understanding of speech issues and how I talk. You gave me my voice back

P6 - My voice is definitely different

P9 - BP and breathing better, & my memory is getting better. I'm forgetting less

P10 - I'm not as short of breath and my voice has definitely improved… Not sure, we're mostly doing that, my pills go down easier

P1 - My voice is stronger, I'm breathing better and I'm thinking better

P7 – I feel like my lungs are clearer & work better. The flutter needs to be adjusted, but it makes it easier to cough up

P8 - puffballs, because I can actually see myself getting better. Those big ones are no joke!

This theme again shows the participants reporting perceived improvements; however, they are not easy to corroborate by simply reviewing a chart or speaking with floor staff/care team members.

Discussion

This section will address the three research questions for this project and provide a basic framework in which the results can be understood and interpreted.

Research question one

- How has respiratory muscle strength training affected a bariatric patients' overall participation in the Osborn Bariatric Program?

The themes that addressed this question are those of (a) Physical aspects of overall program performance; and (b) perceived progress. All thirteen of the participants in this study reported feeling as though they had made progress with the overall OBP. However, several expressed that they felt that they had made

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progress, but when asked to clarify or expand upon their responses they felt unable to fully 'put it into words.' Subsequently, many participants identified progress or improvements; however, these specific gains could not be correlated to hard data or were not included in documented data for a variety of reasons.

Theme 1: Physical aspects of overall program performance

This theme became evident when analyzing the participants response to the question regarding how they were walking now, after starting the breath support training. The participants referring to the 'physical aspects' of therapy were indicating either walking or working with physical or occupational therapy to do exercises and functional tasks. Also mentioned was that they felt that the respiratory muscle strength training affected their alertness, sleep patterns, decreased their tiredness and helped with endurance during activity. These additional themes will be discussed below.

Theme 2: Perceived progress

The largest overarching theme identified was "perceived progress." I call it perceived, as all of the participants reported non-quantifiable and non-verifiable improvements (*e.g.,* 'progress faster,' enjoying therapy better,' *etc.*). This lack of ability to quantify empirically results remains a barrier for treating clinicians as progress with Long-Term Care (LTC) treatment at a Skilled Nursing Facility (SNF) must be able to be synthesized into a numeric score or easily reportable and comprehensible by other clinicians and insurance program reviewers.

Perceived progress, nonetheless, is an important factor for the participants. It is their realizations that they have benefitted from the breath support training program. With long-term care, the progress and gains tend to be small and require a significant time investment. These small improvements can sometimes be overlooked by the participants in the grand scheme of their overall journey to improved wellness and goals of being discharged to a lower level of care.

The follow up question, in an attempt to elicit more in-depth responses and also to tease out what the participants felt was beneficial from the rest of the program, the following question was asked.

- How has voice and breath support training helped their overall progress in the program?

The participants responses revealed a number of themes that answered this question, many of which touched on Quality of Life (QOL) measures. These included (a) recovery time; (b) techniques and (c) integration of techniques with PT/OT therapy.

Theme 3: Recovery time

When addressing the question of how the voice and breath support training program has helped the participants in their overall progress in the Osborn Health and Rehab Bariatric Program, the most common response was that of recovery time. The participants stated that they felt that they now recovered faster, required fewer rest breaks or "standing rest breaks" (as promoted by PT and OT) or that they were able to recover more easily without experiencing dyspnea as severe as before they began the breath support training. This theme is echoed in the existing research and is congruous with the findings of Miller, Silva, et.al., Villiot-Danger, et. al., which all discussed the multiple features of RMT/RMST with obese patients and their performance on tasks including the six-minute walk test [3,10,11]. However, when reviewing the literature and treatment studies, I noted that the average BMI being studied was 34-39 and the participants in this pilot study are all BMI >41, with many >70. There was no literature discussing data sets of participants with BMI >70.

Dyspnea is a common concomitant symptom for patients with obstructive sleep apnea and the study participants also discussed this as being a factor limited to their progress within the overall OHRBP. They also discussed their hope that the decreased recovery time and decreased feeling of dyspnea will allow them to do more during PT and OT, progress faster and discharge sooner to a lower level of care.

Theme 4: Techniques

Another theme that was revealed by thematic analysis of the data was that of technique use by the participants. In addition to the RMST, all participants are taught Oropharyngeal Exercises (OPEs) which are a staple in OSA protocols and snoring research, diaphragmatic breathing, OPEP "fluttervalve" use (per request of NP or MD managing the participants' overall plan of care) and inhalation/exhalation coordination tasks to target breath support for speech [5-9,12,13]. The participants reported that they are using these techniques to help with several aspects of their plan of care, including: To reduce anxiety with diaphragmatic breathing, to aid in recovery during exertion tasks using diaphragmatic breathing and by using RMST and/or inhalation/exhalation tasks before and during exertion tasks (*i.e.,* walking, wheelchair propulsion tasks and PT/OT workouts). The participants also reported feeling less tired overall when using the different techniques for voice and breath support training. This is congruous with the literature Silva, et. al., Guimarães, et. al., Ieto, et. al., which discusses the use of sleep quality

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questionnaires and various ratings scales to report the improved sleep patterns experienced by the participants in their respective research studies and literature reviews [3,12,13].

Theme 5: Integration of techniques with PT/OT therapy

The final theme that addresses the research question of 'How has voice and breath support training helped their overall progress in the program,' is that of integration of techniques with PT/OT therapy. As the voice and breath support program is only one component of the OHRBP, it is designed to integrate with the already established policies and procedures with the PT and OT components.

Some of these, are very similar to the above noted themes, in that they mention recovery time or use of specific techniques; however, when asked for clarification, these participants all described the use during treatment sessions and the focus was not on only the recovery time or the techniques. The participants reported several QOL aspects related to this integration of techniques, as detailed below.

P6: My workouts are better and easier.

P13: Not doing the "dog pant," and easier to catch my breath! When Rhea & I were walking, before I knew it, we were at station one! given me, helped me, blah blah…helped me with breathing in general.

P6: if it wasn't for the breathing stuff, OT & PT wouldn't be what it is.

P13: With breathing – it allowed me to focus more on therapy.

P8: I've definitely progressed, it's harder than it seems. Progressed with memory and things too.

P4: It's affected how I breath when talking, standing, walking while pushing my wheelchair.

There is currently a push in the clinical realm to promote interprofessional collaboration and promote carryover of trained techniques into 'real world' and functional tasks. For these participants, their functional tasks are focusing on weight loss, improving their overall wellness and working towards the goal of progressing from bed-bound, usually for several years, to functional mobility and safely discharge to a lower level of care or independence.

The responses from the participants' transcripts above, illustrate how they are carrying over the already trained voice and breath support techniques.

Research question two

- What Quality of Life (QOL) improvements has the bariatric patients reported related to the voice and breath support training program?

The theme that directly answered this research question is that of Quality of Life (QOL). The semi-structured interview revealed the participants attitudes towards their participation in the voice and breath support training as part of the OHRBP and they reported several QOL improvements that they felt affected their progress. Some QOL factors were noted by the PI and reported by the participants anecdotally during treatment sessions as well as during the semi-structured interview. Four subthemes were identified, including (a) calming/coping; (b) sleep; (c) control/in tune with body and (d) vanity. Many of these subthemes were not expected, nor do they appear in the current literature on snoring or OSA that were referenced for this project.

Theme 6: Quality of Life (QOL)

Theme 6 - subtheme 1: Calming/Coping: This subtheme was not previously identified in the literature review performed for this study. The use of the techniques to address anxiety was briefly mentioned above; however, an in-depth review of the data revealed that this was referred to by 9 of the 13 participants directly. They discussed not only lowering anxiety with the breathing techniques, but also to promote relaxation, use to prepare before transfers or stressful events and simply to 'calm me down.' Participant 12 reported using the OPEs (Masako and roof scrape) as a calming activity, coupled with the diaphragmatic breathing techniques, to promote calmness when he did not have the breath support tools (RMST or OPEP devices) were not available or he felt they were not appropriate for the situation. Participant 7 indicated that the breath support techniques, in addition to calming, also helped her to cope with environmental sensitivities, including scent sensitivity and felt that she not only remained calm, but also 'don't cough as much as I used to.' The participants all reported that these QOL improvements affected their attitudes towards residential living at the facility, in a communal living situation that was very different from their baseline situations.

Theme 6 - subtheme 2: Sleep: This theme was the only one identified that was expected. There is a wealth of literature examining quantitative and qualitative measures of sleep for Obstructive Sleep Apnea (OSA) and literature on snoring treatment [3-9]. Overall, 8 of the 13 participants directly mentioned that their sleep was directly affected by participating in the voice and breath support program as part of the OHRBP. It is important to note, not all participants use a CPAP/BiPAP/APAP/AVAPS, nor did all participants use supplemental oxygen during sleep at the time of this

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study. There have been attempts to empirically represent sleep quality (*e.g.,* PSQI and SQS); however, when the PI attempted to administer these to the participants during assessment, none reported feeling they had any sleep issues at baseline, despite their reliance on supplemental oxygen, and/or use of CPAP/BiPAP/APAP/AVAPS. Thus, these sorts of assessments are not included in the assessment or treatment protocols associated with the OBP voice and breath support training program. In addition, regarding the sleeping patterns, the participants also linked sleeping better to feeling less confused, improved memory and cognitive function, not needing to use supplemental oxygen overnight and the use of the breath support techniques when they are unexpectedly woken up.

Theme 6 - subtheme 3: Control/in tune with body: This theme was identified by female participants as part of the semi-structured interview. This theme was pervasive for participant 5 and she discussed it in detail throughout her semi-structured interview. The participants reported feeling that the breath support training made them feel more 'in tune' with their body and their breathing. As a rehab therapist for 9.5 years, with all of that being in a SNF, one of the biggest reported concerns by skilled and long-term care residents, especially the females, is that of loss of autonomy related to needing assistance with ADLs/personal tasks, loss of independence, *etc.* Having participants identify the feeling of the mind-body connection and increased sense of control over their body, surroundings and situation is significant. Participant 5 stated 'like the deep breathing (diaphragmatic breathing) exercises the most, it makes things manageable. I'm in control of my health!' This participant demonstrates adverse behaviors and this report of feeling she has increased control over her body, affects her interactions with floor staff and her environment. Though impossible to quantify, this affects not only the participants QOL, but also the amount of assistance from the floor staff and other staff's QOL as well.

Theme 6 - subtheme 4: Vanity: This subtheme was unexpected to the PI and arose during the semi-structured interview. Only one participant, P11, reported this finding in this way. This differs from the subthemes of 'sleep' and 'physiological changes,' in how the participant responds. Meaning, instead of reporting that he no longer uses supplemental oxygen or that his oxygen orders were changed, both of which were reported by other participants, he states 'no cannula and no daytime oxygen!' This theme was mentioned 8 times during his semi-structured interview, making it a significant subtheme. Follow up questions and discussion with facility staff revealed that this could likely be related to cultural perception and that appearances/vanity/machismo are more important to this participant than to the others, who choose to focus on their oxygen orders being changed. (This is discussed in the Theme 7: Physiological changes section below). This subtheme is related to that of Theme 6 – subtheme 3: Control/in tune with body, in so much as to this participant, they are expressing increased feelings of autonomy and normalcy, that they did not experience before completing the voice and breath support program as part of the OHRBP.

Research question three

- What physiological (measurable) improvement has the bariatric patients demonstrated related to the voice and breath support training program?

Theme 7: Physiological changes

All of the participants identified some manner of physiological changes that they attributed to their participation in the voice and breath support program at Osborn Health and Rehab. Their main focus was on either their oxygen levels or CO_2 levels or some aspect related to either of those measures. The literature also indicates use of different measures including six-minute walk test, BP and O_2 levels as indicators as improvement; however, there is significant consensus in the literature that there is not a statistically significant different in timing of completion for the six-minute walk test (with physical therapy) pre- and post-intervention, so this measure was not included in the assessment of patients at OHR in the Bariatric Program, nor was the measure used for this project [4,9,11,13].

The most commonly reported physiological measure is that of oxygenation levels, as read in SpO_2% *via* pulse ox by either the participant or the floor staff that manage their care. The next most commonly reported changes are decrease in CO_2 levels (as determined by a Basic Metabolic Panel (BMP) as requested by participants provider and accessible in their charts) and decreased Blood Pressure (BP). This BP finding is congruous with the findings of Kaura, et. al., as a physiological measure of improvement noted following treatment plan using OPEs and diaphragmatic breathing techniques [9].

Participants also discussed 'choking' or concomitant swallowing concerns, that have improved following implementation of the voice and breath support training program. All of these reported physiological measures were being tracked by either facility floor staff or participants' providers and were being monitored normally as part of the participants' overall plan of care, they were not checked specifically just for reporting during this project.

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Theme 7 - subtheme 1: Participants' self-reported physiological measures: This theme varies from Theme 7: Physiological changes, in that they cannot be confirmed or correlated by information documented in the participants' charts. These observations were all self-reported by the participants and anecdotal corroboration from either SLP, floor staff or providers were elicited. Participants most commonly self-reported voice changes, stating 'My voice is definitely different' -P6, 'My voice is stronger, I'm breathing better and I'm thinking better' -P1, 'My voice has gotten stronger' -P2 and 'You gave me my voice back' -P2. These are highly subjective, as all participants did self-report vocal deficits as evidenced by VHI scores at start of care; however, their voices were audible and would likely be judged as "appropriate" by unfamiliar listeners. The second most commonly self-reported physiological measure is that of improved swallowing, including improved ability to swallow pills/medications.

While swallowing function was being monitored by SLP, the participants all had concomitant diagnoses of oropharyngeal dysphagia, with recommendations for FEES (forthcoming) due to body habitus. At the time of this study's completion, FEES assessments for this population were not readily available, so symptom tracking, use of strategies and OPEs for the voice and breath support program were adjusted to allow for more swallowing focused interventions, including adding Supraglottic swallow maneuver to the protocol. The final self-reported physiological measure is that of improved breathing/improved breath support. While the level of resistance on RMST devices for both IMST & EMST tasks are tracked each treatment session, as is the perceived Effort to complete the RMST tasks, the participants would anecdotally report feeling as if they were stagnating on progress or had been progressing regardless of the documented performance.

Overall, all participants reported feeling as though they experienced physiological improvements related to their training on voice and breath support as part of the OHD Bariatric Program. However, it is important to consider that the overall plan of care for these participants is quite complex and the affect of outside influences and/or other changes made (medication, new equipment, bed function/positioning capabilities, wheelchair accessibility and positioning, *etc.*) could also play a causal factor in the perceived progress that the participants reported.

Conclusions and Implications

Results of this study reveal that bariatric long-term care residents have demonstrated both physiological and quality of life improvements since starting breath support and voice treatment with a speech-language pathologist. This study, though small in nature, attempts to further our knowledge on bariatric patients that receive voice and breath support training to attempt to improve the functionality and quality of life of the bariatric patients that are a part of the Osborn Bariatric Program.

Scant literature is available looking at the specialized needs of super morbidly obese patients and their concomitant respiratory and diaphragmatic deficits that lead to increased dyspnea and affect their overall progress in a standardized rehabilitation framework.

Future research related to this could include: the role of dysphagia in pulmonary sequalae (FEES for bariatric patients), sensory integration techniques to promote self-regulation during stressful situations and collaboration with providers (MDs/NPs) to identify medical concomitant conditions and develop an overall treatment protocol for this specialized population.

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