CHAPTER 4

RESULTS

The aim of the present research was to study audiovestibular profile and quality of life in individuals with BPPV. Two groups of participants included in the study, Group I consisted of 40 healthy controls, 21 males and 19 females, between the ages of 40 to 70 years. Group II consisted of 92 individuals with BPPV, 51 males and 41 females in the age range of 40 to 70 years. Out of 92 participants with BPPV, 86 participants had posterior canal type BPPV, while six participants had horizontal canal type BPPV. In all, 40 participants had right sided BPPV while 52 participants had left sided BPPV. Complete audiovestibular test battery revealed that among 92 participants with BPPV, 30 participants had primary BPPV, 15 participants had BPPV secondary to vestibular neuritis, 10 individuals had BPPV secondary to Meniere's disease and 37 had BPPV secondary to some unknown peripheral vestibular pathology. To categorize the participants with BPPV secondary to Meniere's disease (MD), Vestibular neuritis and unknown peripheral vestibular pathology following criteria were used.

BPPV secondary to Meniere's disease (BPPV-MD): Criteria for diagnosis of Meniere's disease (MD) was based on the guideline given by AAOHNS (1995). Persons with two or more definite episodes of spontaneous vertigo lasting for twenty minutes or longer, documented hearing loss on at least one occasion, and tinnitus or aural fullness in the ear with the hearing loss were diagnosed to have MD. Positive test findings on Dix-Hallpike test or Roll Maneuver in these individuals indicated BPPV secondary to MD.

BPPV secondary to vestibular Neuritis (BPPV-VN): Individuals with positive test results on Dix-Hallpike test or Roll Maneuver with history of sudden spontaneous

vertigo which slowly decreased over days, unilateral canal paresis on caloric test and/or absence of unilateral cVEMP response and no relevant auditory symptoms were considered as BPPV secondary to Vestibular Neuritis (VN)

BPPV secondary to Unspecific Vestibular Pathology (BPPV-UVP): Individuals with positive results on Dix-Hallpike test or Roll Maneuver with a generalized history of dizziness or imbalance, and abnormal results on either cVEMP or caloric test were categorized as BPPV secondary to Unspecific Vestibular Neuritis (UVP).

Shapiro Wilk's test of Normality was carried out to study if the data is normally distributed or not. The results revealed $p < 0.05$ indicating non-normal distribution of the data. Therefore non parametric tests were carried out to investigate the objectives of the study. Results showed non-normal distribution of the data ($p < 0.05$). Results obtained are discussed under following headings:

4.1 Audiovestibular findings in participants with BPPV

4.1.1 Results on Pure Tone Audiometry

4.1.2 Results on VNG test

4.1.2.1 Results on Spontaneous Nystagmus, Positional Nystagmus and Gaze Nystagmus tests

4.1.2.2 Results on caloric test

4.1.3 Results on cVEMP

4.2 Self perceived handicap and general quality of life in person with BPPV

4.2.1 Self perceived handicap and general quality of life Quality of life in subgroups of BPPV based on etiology

4.2.2 Self perceived handicap and general quality of life Quality of life in subgroups of BPPV based on vestibular findings

4.3 Factors affecting self-perceived handicap and quality of life (QOL)

4.3.1 Effect of age

4.3.2 Effect of gender

4.3.3 Effect of frequency of dizziness

4.3.4 Effect of Duration of dizziness

4.3.5 Effect of associated hearing loss

4.1 Audiovestibular finings in participants with BPPV

4.1.1 Results on Pure Tone Audiometry

Pure tone audiometry was carried out for participants of both the groups. Table 4.1 shows the mean and standard deviation (SD) values of pure tone average (average of 500 Hz, 1000 Hz and 2000 Hz) for right and left ears of both the groups. For the participants of Group II, mean PTA was further computed separately for ears with and without BPPV. It can be observed from the table 4.1 that ears with BPPV as well as ears without BPPV of Group II had higher pure tone average than matched ears of Group I.

Table 4.1 *Mean and SD of pure tone average for participants of Group I and Group II*

Groups		**Group I**	**Group II**		
			Ear with BPPV	Ear without BPPV	Ears with and without BPPV combined
Right Ear PTA	N	40	40	52	92
	Mean (dBHL)	19.1	25.4	25.4	25.26
	SD (dBHL)	3.6	13	8.4	10.78
Left Ear PTA	N	40	52	40	92
	Mean (dBHL)	18.3	23..3	24.4	24.3
	SD (dBHL)	2.9	11.5	11.2	11.2

Note: N: Number of ears

Table 4.2

Results of Mann-Whitney U test comparing pure tone average of Group I and II

Between Group and between Ears comparison	**Z value**	***p* value**
Right Ear with BPPV of Group II Vs right ear of Group I	**2.78**	**0.021**
Right ear without BPPV of Group II Vs right ears of Group I	**2.43**	**0.045**
Right Ear with BPPV of Group II and Right ears without BPPV of Group II	1.3	0.84
Left Ear with BPPV of Group II and matched left ears of Group I	**3.57**	**0.015**
Left ear without BPPV of Group II and matched left ears of Gr I	**2.35**	**0.035**
Left Ear with BPPV of Group II and Left ears without BPPV of Group II	1.9	0.55

Table 4.2 shows the results of Mann-Whitney U test on comparison of PTA of the two groups. PTA of ears with BPPV and ear without BPPV of Group II were separately compared with PTA of Group I. The analysis was carried out separately for right and left ears. Further PTA of ears with and without BPPV among the participants of Group II were also compared. It can be observed from Table 4.2 that there was a significant difference between the PTA of ears with BPPV when compared to the ears of healthy controls, for both right and left ears. A significant difference was also seen between ears without BPPV of Group II and ears of healthy controls for both right and left ears. There was no significant difference between the PTA of ears with

BPPV and ears without BPPV of Group II. Further analysis was carried out to compare the PTA of subgroups of Group II with those of Group I.

PTA of subgroups of BPPV

PTA was calculated separately for persons with primary BPPV and those with secondary BPPV. Among those with secondary BPPV, PTA was calculated separately for persons with BPPV due to MD, BPPV due to VN and BPPV due to UVP. This analysis was done as audiological profile may vary depending upon etiology. Table 4.3 indicates the Mean and SD values of PTA for each of the subgroups.

Table 4.3: *Mean and SD of pure tone average for different subgroups*

Groups	**RIGHT EAR (PTA) dBHL**				**LEFT EAR (PTA) dBHL**			
	Ears with BPPV		**Ears without BPPV**		**Ears with BPPV**		**Ears without BPPV**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
BPPV-IP	20 (N:12)	2.7	21 (N: 18)	2.18	22 (N: 18)	3.6	22 (N:12)	2.3
BPPV–MD	38 (N:5)	13	30 (N: 5)	22	42 (N:5)	10	36 (N: 5)	11
BPPV-VN	19 (N: 8)	3.5	20 (N: 7)	3.9	22 (N: 7)	5	20 (N: 8)	3.6
BPPV-UVP	29 (N:13)	19	25 (N: 24)	07	26 (N: 24)	13	23 (N: 13)	10

Note:N: Number of ears; BPPV-IP: Primary/ideopathic BPPV; BPPV-MD: BPPV secondary to Meniere's disease; BPPV-VN: BPPV secondary to VN; BPPV-UVP: BPPV secondary to unspecific vestibular pathology

It can be observed form Table 4.3 that ears with primary BPPV and ears with BPPV secondary to VN had better PTA compared to ears with BPPV secondary to MD or UVP. Mann-Whitney U test (refer Table 4.4) revealed that ears with primary BPPV

differed significantly from those with BPPV secondary to MD and ears with UVP. Ears with BPPV secondary to MD and those with BPPV secondary to UVP also differed significantly from ears of healthy control group. However, PTA of ears with primary BPPV and those with secondary BPPV due to VN did not differ significantly from those of healthy controls. Also there was no significant difference between PTA of ears with primary BPPV and ears with BPPV secondary to vestibular Neuritis.

Table 4.4: *Results of Mann-Whitney U test comparing PTA of Group I and subgroups Group II*

Group Comparisons	**RIGHT EAR**		**LEFT EAR**	
	Z	*p*	Z	*p*
Primary BPPV and Group I	0.13	0.14	0.35	0.23
BPPV secondary to MD and Group I	**3.4**	**0.001**	**2.6**	**0.04**
BPPV secondary to VN and Group I	0.91	0.25	0.21	0.45
BPPV secondary to UVP and Group I	**2.3**	**0.01**	**1.4**	**0.02**
BPPV secondary to MD and primary BPPV	**3.1**	**0.01**	**1.8**	**0.02**
BPPV secondary to VN and Primary BPPV	0.00	0.34	1.02	0.56
BPPV secondary to Unspecific vestibular pathology and primary BPPV	**1.40**	**0.04**	**1.08**	**0.04**

4.1.2 Results on VNG test

4.1.2.1 Results on Spontaneous Nystagmus, Positional Nystagmus and Gaze Nystagmus

Spontaneous Nystagmus: Monocular Frensel's goggles were used to record spontaneous activity of eye ball movements when the patient was sitting with the head erect. The average slow phase velocity (SPV) was calculated for the strongest three beats in goggle closed and open condition. Numbers of individuals having spontaneous nystagmus with SPV values more than 6 degree/sec were calculated.

Table 4.5 shows the number of persons showing nystagmus. It can be observed from the table that none of the participants of Group I showed spontaneous nystagmus. Some participants of Group II showed spontaneous nystagmus in vision denied condition but no one had spontaneous nystagmus in vision enabled condition.

Positional Nystagmus Test: Positional Nystagmus was evaluated during positional testing. The average SPV was calculated for the three strongest consecutive beats with participant's head in three different positions i.e. supine left, supine right and hyperextended in vision enabled and denied condition. Positional nystagmus with SPV value more than 6 degree/sec was considered to be positive. It was observed that individuals with positional nystagmus had direction fixed nystagmus irrespective of their head position and it was more often present in eyes closed condition than eyes open condition. Number of individuals of Group I and II showing positional Nystagmus is shown in Table 4.5

Gaze Test: Presence of gaze nystagmus was evaluated during Gaze test in vision denied and vision enabled condition. The nystagmus was considered to be positive if SPV values exceeded 6 degrees/sec. Gaze evoked nystagmus was calculated in 4 conditions with head erect positions eyes fixated at 30 degrees to the right, eyes fixated at 30 degrees to the left, eyes fixated at 30 degrees above and eyes fixated at 30 degrees below. Table 4.5 depicts the number of individuals with gaze nystagmus for the two groups of participants. It can be seen from the table that none of the participants of Group I has Gaze evoked nystagmus, but it was observed in some of the participants of Group I in vision denied condition.

Table 4.5 *Number of participants of Group I and II showing nystagmus across Spontaneous, Positional and Gaze Test*

Test	**Group I (Vision Denied)**	**Group II (Vision denied)**	**Group I (Vision Enabled)**	**Group II (Vision Enabled)**
Spontaneous Nystagmus test	0	08	0	0
Positional test (Supine Left)	0	03	0	0
Positional test (Supine Right)	0	16	0	0
Positional test (Hyperextended)	03	18	0	0
Gaze at 0 degree	0	06	0	0
Gaze at 30^0 Right	0	05	0	0
Gaze at 30^0 Left	0	06	0	0
Gaze at 30^0 Above	0	0	0	0
Gaze at 30^0 Below	0	0	0	0

To summarize, abnormal nystagmus was not observed for any participants in vision enabled condition in both the groups. In vision denied condition, nystagmus was present in more number of individuals in Group II than Group I for all the tests. More number of participants of Group II had nystagmus on the positional test than on spontaneous and gaze nystagmus test. Chi-Square test was carried out to check if this

difference between the groups was statistically significant. The results of Chi-Square test shown in Table 4.6 indicates that the difference was statistically significant for all the tests except for Gaze nystagmus in 2 conditions (30 degree above and 30 degree below).

Table 4.6. *Results of Chi-Square test comparing Group I and Group II for number of persons with nystagmus*

Test	**Comparison of Group I and Group II**		
	Chi-Square value	**Df**	***p* value**
Spontaneous Nystagmus test	80	1	.013
Positional test (Supine Left)	29	1	0.03
Positional test (Supine Right)	42	1	0.00
Positional test in (Hyperextended)	41	1	0.00
Gaze at 0 degree	74	1	0.03
Gaze at 30^0 Right	75	1	0.01
Gaze at 30^0 Left	72	1	0.013
Gaze at 30^0 Above	.88	1	0.48
Gaze at 30^0 Below	.86	1	0.46

Nystagmus in subgroups of Group II

It was observed that number of participants displaying nystagmus on spontaneous, gaze and positional nystagmus tests were not same across different subgroups of BPPV. Therefore analysis of number of persons displaying nystagmus on Spontaneous, Positional and Gaze test was carried out separately for participants with

primary and secondary BPPV. Table 4.7 shows the number of participants with primary and secondary BPPV showing nystagmus on Spontaneous, Positional and Gaze test. Presence of spontaneous nystagmus, positional nystagmus and gaze evoked nystagmus was more among the participants with secondary BPPV than primary BPPV. Among those with secondary BPPV, the occurrence of nystagmus on all the three tests was more common in participants with BPPV secondary to VN followed by those with BPPV secondary to MD and UVP

Table 4.7 *Number of participants showing nystagmus across Spontaneous, Positional and Gaze test in different subgroups*

	In vision denied condition						
Group	**Spontaneous Nystagmus test**	**Positional supine Right**	**Positional Supine Left**	**Positional (Hyperex-tended)**	**Gaze at 0**	**Gaze at Right 30 degree**	**Gaze at Left 30 degree**
BPPV-IP	0	3	0	3	0	0	0
BPPV - MD	02	6	0	6	02	01	01
BPPV - VN	05	8	3	8	04	04	05
BPPV-UVP	01	1	0	02	0	0	0

Note: BPPV-IP: Primary/ Ideopathic BPPV, BPPV-MD: BPPV secondary to Meniere's disease, BPPV-VN: BPPV secondary to VN, BPPV-UVP: BPPV secondary to unspecific vestibular pathology

4.1.2.2 Results of caloric test

Caloric Nystagmus was evaluated during bithermal caloric testing. SPV of nystagmus was measured after 20 sec of cold/warm air irrigation. Slow Phase Velocity (SPV) was calculated based on the three strongest consecutive non-artifactual beats occurring during the 10 sec interval in which the nystagmus was most robust. Table 4.8 shows mean and SD values of SPV for all four irrigations, for Group I and II. It

can be observed that SPV values for the warm irrigation was higher than those of cold irrigation for both groups of participants. Overall mean SPV values were lower among the individuals with BPPV (Group II) when compared to healthy controls (Group I). Further, SPV values between ears with BPPV and ears without BPPV did not show any consistent pattern. Both ears irrespective of the side of BPPV seems to be affected among the participants of Group II on the caloric test.

Table 4.8: *Mean and SD values of SPV on caloric test for Group I and Group II*

		SPV	**Group I**	**Group II**		
				Ear with BPPV	**Ears without BPPV**	**Ears with and without BPPV combined**
Right Ear	Right Warm	Mean	14.25(N: 40)	9.7 (N: 40)	8.8 (N: 52)	9.51 (N: 92)
		SD	6.68	8.8	4.5	5.15
	Right cold	Mean	14.71 (N: 40)	10 (N: 40)	8.9 (N: 52)	9.00 (N: 92)
		SD	5.84	6	4.9	12.58
Left Ear	Left warm	Mean	14.00 (N: 40)	8.8 (N: 52)	9.2 (N: 40)	9.03 (N: 92)
		SD	5.69	6.3	4.8	5.52
	Left cold	Mean	12.68 (N: 40)	7.1 (N: 52)	8.5 (N: 40)	7.83 (N: 92)
		SD	6.05	4.6	5.4	5.07

Note: N- Number of ears

Comparison was done between SPV values of the participants of Group I and Group II, both for ears with BPPV and ears without BPPV using Mann Whitney U test. SPV vales were also compared between the ears with BPPV and ears without BPPV within the participants of Group II. Table 4.9 depicts the results across four irrigations. Statistically significant difference was found between SPV values of ears of Group II (both with and without BPPV) and matched ears of Group I. However there was no

significant difference between the ears with BPPV and ears without BPPV for all the four irrigations of caloric test among the participants of Group II.

Table 4.9: *Results of Mann-Whitney U tests comparing SPV values of Group I and Group II*

Group Comparisons	**warm irrigation**		**Cool irrigation**	
	Z	***p***	**Z**	***p***
Right ear with BPPV of Group II and right ear of group I	2.8	0.05	4.0	0.00
Right ear without BBPV of Group II and right ear of group I	3.3	0.01	4.2	0.00
Right ear with BPPV and right ears without BPPV of Group II	0.25	0.79	0.36	0.71
Left ear with BPPV of Group II and matched left ear of group I	4.2	0.00	4.7	0.00
left ears without BPPV of Group II and left ear of group I	3.3	0.01	3.2	0.03
Left Ear with BPPV Gr II and ears without BPPV of group II	0.15	2.3	1.2	0.20

Caloric nystagmus among subgroups of Group II

SPV values for each irrigation were calculated separately for participants with primary BPPV and those with secondary BPPV. Table 4.10 shows mean and SD values of SPV for the subgroups across all the four irrigations of caloric test. It can be observed from the table that SPV values were higher for participants with primary BPPV when compared to those with secondary BPPV. Mann-Whitney U test was applied to study if SPV are significantly differing among the subgroups and the results shown in Table 4.11. It can be observed from the table that there was no significant difference between the SPV of ears with primary BPPV and ears of Group

I. The SPV of ears with BPPV secondary to MD did not differ significantly from those of Group Ior those with primary BPPV. However, the SPV of ears with BPPV secondary to VN differed significantly from those of Group I as well as those of ears with primary BPPV for all the irrigations. The SPV of ears with BPPV secondary to UVP differed significantly from those of Group I and ears with primary BPPV only for warm irrigations.

4.10: *Mean and SD values of SPV on caloric test in different subgroups*

		RIGHT EAR				**LEFT EAR**			
		Ears with BPPV		**Ears without BPPV**		**Ears with BPPV**		**Ears without BPPV**	
		RW	RC	RW	RC	LW	LC	LW	LC
BPPV-IP	Mean (degree/sec)	10	8	11	9.5	8.7	8.1	11.4	8.4
	SD	6.4	4.5	6.4	4.2	4.8	6.1	6.1	4.3
BPPV - UVP	Mean (degree/sec)	8.5	8	8.2	8	6.3	8.2	7.8	8.2
	SD	6.2	6	6	6	4.8	2.7	4.9	4.2
BPPV-MD	Mean (degree/sec)	7.6	7.4	10.3	9.3	9	7.3	9.1	6.8
	SD	2.3	2.2	3.5	3	3.5	3	3.5	5.3
BPPV-VN	Mean (degree/sec)	3.4	4.1	4.8	3.2	4.2	3	3	2.8
	SD	2.8	4.7	2.7	1.7	2.4	1.9	3	2.5

Note: BPPV-IP: Primary BPPV, BPPV-MD: BPPV secondary to Meniere 's disease, BPPV-VN: BPPV secondary to VN, BPPV-UVP: BPPV secondary to unspecific vestibular pathology, RW: Right warm, LW: Left warm, RC: Right cold, RW: right warm

Table 4.11: *Results of Mann-Whitney U test comparing SPV values of subgroups of Group II and Group I*

Groups	**Right Ear**				**Left ear**			
	RW		**RC**		**LW**		**LC**	
	Z	***p***	**Z**	***p***	**Z**	***p***	**Z**	***p***
BPPV IP & Group I	0.32	0.34	0.66	0.45	0.34	0.43	0.23	0.73
BPPV-MD & Group I	0.34	0.55	0.70	0.33	0.75	0.84	0.37	0.33
BPPV-VN & Group I	4.8	0.001	3.8	0.012	3.8	0.001	4.2	0.013
BPPV-UVP & Group I	4.1	0.001	0.26	0.32	2.3	0.023	0.52	0.78
BPPV-IP & BPPV-MD	0.74	0.45	0.90	0.23	0.46	0.34	0.51	0.53
BPPV-IP & BPPV—VN	3.8	0.013	2.8	0.013	3.8	0.002	3.2	0.012
BPPV-IP & BPPV-UVP	1.4	0.04	0.16	0.12	1.4	0.043	0.50	0.78

Note: BPPV-IP: Primary BPPV, BPPV-MD: BPPV secondary to Meniere's disease, BPPV-VN: BPPV secondary to VN, BPPV-UVP: BPPV secondary to unspecific vestibular pathology, RW: Right warm, LW: Left warm, RC: Right cold, RW: right warm

Unilateral Weakness: Unilateral Weakness (UW) also called canal paresis was calculated using Jonkee's Formula (Jongkees and Philipszoon, 1964) for both the group of participants. The mean value for Group I was 13 with an SD of 9.0 and the

mean was 18 with an SD of 22.1 for Group II. Comparison of UW between Group I and Group II did not show a significant difference on Mann-Whitney U test (Z= 2.8; *P*> 0.05). However, inspection of individual data showed that some of the participants of Group II had abnormal canal paresis. UW was considered abnormal for the participants of Group II, if it was more than 22 % (mean ± 1 SD of normative data reported by Sarda, Bhat & Vanaja, 2014). It was observed that canal paresis was abnormal in twenty two participants of the Group II including 14 participants with BPPV secondary to VN 2 participants with BPPV secondary to MD, 06 participants of UVP. There were seven participants with bilateral hypoactive responses on all the four irrigations of caloric test.

4.1.3 Results on cVEMP

Cervical Vestibular Evoked Myogenic Potential (cVEMP) was recorded from the participants of both groups. Well replicated P13 & N23 peaks were marked and the amplitude as well as latencies for those peaks were noted down. Table 4.12 shows Mean and SD values of latencies for P13 and N23 peaks and absolute amplitude of P13-N23 complex along with response rate for the participants of Group I and Group II. Results revealed that there were two participants with bilateral absence of cVEMP among the participants of Group I whereas six participants had bilateral absence of cVEMP among the participants of Group II. Among Group II participants, unilateral absence of cVEMP response was observed in five right ears and six left ears with BPPV while it was observed in two left ear and one right ear without BPPV. Chi-square analysis was done to investigate if there was a significant difference in response rate of cVEMP Group II versus Group I. Results revealed that there was a statistically significant difference in response rate of cVEMP of the two groups (x^2= 35, $p < 0.01$).

Further mean latencies of P13 and N23 peaks were similar among the participants of the Group I and Group II for both right as well as left side (Refer Table 4.12). Furthermore, among participants of Group II, mean latencies of P13 and N23 peaks were also similar between the ears with BPPV and without BPPV. However. mean and SD values for absolute amplitude of P13-N23 complex was greater for the right ears with BPPV as compared to right ears without BPPV. Similarly, left ears with BPPV had lower amplitude values compared to left ears without BPPV. Mann-Whitney U test was applied in order to investigate if parameters of cVEMP differs significantly between Group I and Group II. Analysis was also carried out to check if there is a difference between the cVEMP parameters of ears with BPPV and ears without BPPV of Group II. It can be also observed from Table 4.13 that the latency of P13 did not differing significantly ($p > 0.05$) between ears of Group II and Group I. There was no significant difference for the latency of N23 between Group II and Group I. However, the mean absolute amplitude of P13-N23 complex of the ears with BPPV as well as ears without BPPV of Group II differed significantly from that of Group I.

Further, individual data of Group II were inspected to check if the latency or amplitude of peaks were abnormal when compared to the data of Group I. Normative data published by Sarda, Bhat & Vanaja (2012) was used to classify responses as normal or abnormal. cVEMP was considered abnormal if peaks could not be identified or latency and or amplitude value of P13 & N23 were deviating from Mean ± 1 SD value of the published norms. It was observed that out of 92 participants of Group II, cVEMP was abnormal in sixty participants while it was normal in thirty two participants. Further among the 60 participants with abnormal responses, 28

individuals had bilaterally affected cVEMP while 32 persons had unilaterally affected cVEMP.

Table 4.12 *Mean and SD values of various parameter of cVEMP for Group I and Group II*

	Ear		Group I	Group II		
				Ear with BPPV	Ear without BPPV	Ear with and without BPPV combined
N	Number of ears		R:40; L:40	R: 40 L: 52	R: 52 L: 40	R:92; L:92
P13 Latency (ms)	Right ear	Mean	17.00	17.57	16.87	17.18
		SD	1.35	1.83	1.54	1.7
	Left Ear	Mean	16.47	17.47	16.88	17.17
		SD	1.06	1.98	1.69	1.90
N23 23 Latency (ms)	Right Ear	Mean	25.15	24.3	24.72	24.5
		SD	1.8	2.5	1.96	2.19
	Left Ear	Mean	24.02	23.98	24	23.70
		SD	2.19	1.9	2.6	2.10
Peak amplitude of P13-N23 complex (µv)	Right Ear	Mean	59.14	49.74	36.13	44.40
		SD	26.14	42.8	25.9	38.39
	Left Ear	Mean	44.28	27.76	36.13	34.25
		SD	28.56	27.14	25.9	25.60

Note: N: No of ears in each group, R: Right side; L: Left side

Table 4.13 *Results of Mann-Whitney U test comparing cVEMP parameters between Group I and Group II*

Group	P13 Latency		N23 Latency		Amplitude Asymmetry	
	Z	***p***	**Z**	***p***	**Z**	***p***
Right ear with BPPV of Group II and matched right ear of Group I	1.29	0.59	1.29	0.059	2.82	0.018
Right ear without BPPV of Group II and matched right ear of Group I	0.424	0.672	2.44	0.055	3.45	0.001
Right ear with BPPV & right ear without BPPV of Group II	1.97	0.055	1.13	0.258	1.377	0.169
Left ear with BPPV of Group II and matched left ear of Group I	1.6	0.10	1.98	0.057	3.9	0.00
Left ears without BPPV of Group II and matched left ear of Group I	1.15	0.056	1.288	0.051	3.49	0.00
Left Ear with BPPV & left ear without BPPV of Group II	1.069	0.285	0.098	0.324	0.320	0.74

Chi-Square test was conducted to investigate if there were significantly more number of ears in Group II showing abnormal responses on any of the parameter of cVEMP as compared to a Group I. Table 4.14 shows that the difference between the groups was statistically significant.

Table 4.14: *Results of Chi-Square test comparing Group I and II for number of ears with abnormal responses*

Parameters	**Chi-Square value**	**Df**	***p* value**
P13 Latency	4.9	01	0.040
N23 Latency	6.9	01	0.04
Absolute Amplitude of P13-N23 complex	32	01	.000

cVEMP in different subgroups of Group II

Results on cVEMP test may vary depending upon type of associated vestibular pathology in individuals with BPPV. Therefore analysis was carried out separately for subgroups of Group II. Table 4.15 shows that Mean and SD values for latencies of P13 and N23 peaks and absolute amplitude of P13-N23 complex for ears with BPPV and ears without BPPV, for both right and left ears. It can be observed that amplitude values were consistently lower for ears with BPPV secondary to MD, VN or UVP as compared to those with primary BPPV. Among those participants with secondary BPPV, lowest amplitude values were seen for ears with BPPV secondary VN followed by those with BPPV secondary to UVP. However such pattern was not observed for latency parameter of P13 and N23 peaks.

Table 4.15 *Mean and SD values for cVEMP parameters for subgroups of Group II*

cVEMP parameters			**P13 latency**		**N 23 latency**		**Amplitude**	
			Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
BPPV-IP	Ears with BPPV	Right ear	16.8	2.1	23.8	1.6	55	24
		Left ear	17	3	24	1	26	25
	Ears with BPPV	Right ear	15.8	1.04	24.6	2.0	90.65	60.14
		Left ear	16	1	25	2	55	22
BPPV-MD	Ears with BPPV	Right ear	17	1.1	24	1.2	35	21
		Left ear	18	1.2	23	2.2	31	21
	Ears with BPPV	Right ear	15	1.2	21	1.6	15	2.9
		Left ear	18	2.8	23	2.2	4.4	2.3
BPPV-VN	Ears with BPPV	Right ear	17	1.1	25.5	1.4	35	23
		Left ears	17.3	3	23	1	46	25
	Ears without BPPV	Right ear	16	1.2	26	2.2	4.5	2.7
		Left ear	17	2.8	24	2.8	4.2	2.4
BPPV-UVP	Ears with BPPV	Right ear	17	1.1	25	1.9	29	21
		Left ears	17	1.5	23	1.9	23	14
	Ears without BPPV	Right ear	17	1.4	26	2.0	28	20
		Left ear	17	1.5	22.8	2.1	27	24

Note: BPPV-IP: Primary/ideopathic BPPV, BPPV-MD: BPPV-VN: BPPV secondary to VN, BPPV secondary to Meniere's disease, BPPV-UVP: BPPV secondary to unspecific vestibular pathology

Table 4.16 *Results of Mann-Whitney U test for cVEMP parameters comparing subgroups of Group II and Group I*

Group	**Right Ear**						**Left ear**					
	P13 latency		**N23 Latency**		**Amplitude of P13-N23**		**P13 Latency**		**N23 latency**		**Amplitude of P13-N23**	
	Z	*p*	Z	*p*	Z	*p*	Z	*p*	Z	*p*	Z	*p*
BPPV-IP& Gr I	0.00	1	0.5	0.58	0.00	0.99	0.2	0.83	0.31	0.75	0.03	0.97
BPPV-MD &Gr I	0.56	0.54	0.01	1.0	2.2	0.02	0.68	0.51	2.5	0.12	3.4	0.00
BPPV-VN &Gr I	0.42	0.51	2.53	0.02	3.9	0.00	0.43	0.65	3.54	0.00	3.2	0.00
BPPV-UVP &Gr I	1.7	0.08	0.6	0.4	4.6	0.00	0.28	0.74	2.45	0.009	4.3	0.00
BPPV-IP & BPPV-MD	0.72	0.42	0.2	0.8	2.1	0.02	0.6	0.5	0.6	0.17	3.4	0.001
BPPV-IP & BPPV-VN	0.65	0.45	2.5	0.02	3.2	0.001	0.042	0.966	3.5	0.00	3.9	0.00
BPPV-IP & BPPV - UVP	0.043	0.9	0.6	0.4	3.4	0.00	0.25	0.24	2.45	0.009	3.4	0.001

Note: BPPV-IP: Primary BPPV, BPPV-MD: BPPV secondary to Meniere's disease, BPPV-VN: BPPV secondary to VN, BPPV-UVP: BPPV secondary to unspecific vestibular pathology, *Gr: Group*

Mann-Whitney U test was carried out to examine whether latency and amplitude parameter differed significantly among ears of Group I and subgroups of Group II. It was observed (refer Table 4.16) that neither latency nor amplitude parameter of cVEMP differed significantly between ears with primary BPPV and ears of healthy control group. However, the amplitude of ears with BPPV secondary to MD, VN or UVP differed significantly from those of Group I as well as those with primary BPPV. Ears with BPPV secondary to MD showed a significant difference from Group I only for amplitude of P13-N23and there was no significant difference between ears with BPPV secondary to MD and those of primary BPPV for any of the latency parameters. Latency of N23 of ears with BPPV secondary to VN differed significantly from those of Group I as well as those with primary BPPV. Latency of N23 of ears with BPPV secondary to UVP showed a significant difference from those of Group I and those of ears with primary BPPV only for left ear. There was no significant difference among any of the groups for latency of P13.

4.2 Self-perceived handicap and general Quality of Life in individuals with BPPV

4.2.1. Self-perceived handicap and general Quality of Life in subgroups based on etiology

Marathi version of Dizziness Handicap Inventory (DHI – Marathi) which is a disease specific questionnaire and WHOQOL- BREF, a general quality of life measure were administered in an interview format for both the groups of participants. Mean and standard deviation (SD) was calculated for each domain of DHI and WHOQOL-BREF scales for the two groups. Mean and SD was also calculated separately for the subgroups i.e. Group II-IP, BPPV-MD, BPPV-VN, BPPV-UVP as the self-perceived handicap and quality of life may vary depending on the associated pathology. It can be observed from Table 4.17 that the self-perceived handicap as

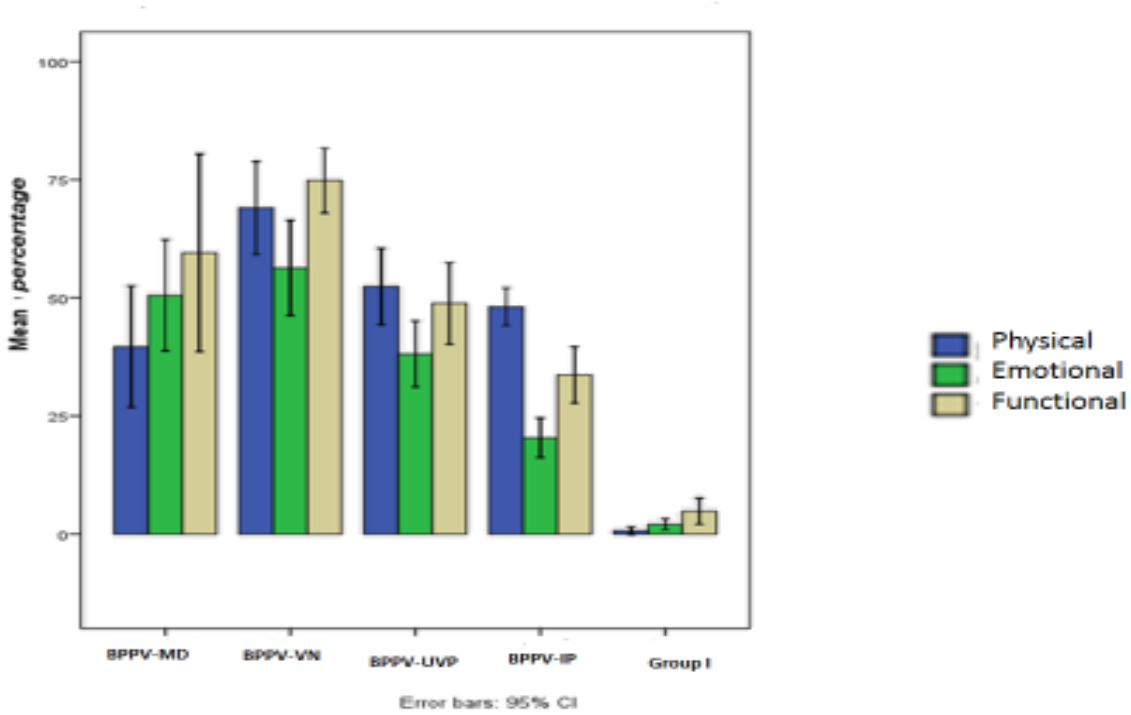
well as general quality of life was affected among the participants of all the subgroups of Group II. Further inspection of the table reveals that self-perceived handicap was maximum in individuals with BPPV - VN followed by individuals with BPPV-UVP.

Table 4.17: *Mean and SD values of Group I and Group II for the domains of DHI*

Domains		**Group I**	**BPPV-IP**	**BPPV-MD**	**BPPV-VN**	**BPPV-UVP**	**All groups combined**
Physical (Max score: 28)	Mean	1.92	13.21	13.60	21.13	16.05	15.75
	SD	1.5	2.9	5.31	5.41	6.05	5
Emotional (Max score : 36)	Mean	0.25	7.7	16.4	20.4	14.8	14
	SD	.67	3.7	5.87	6.6	6.2	5
Functional (Max score: 36)	Mean	0.82	11.5	20.0	27.2	19.9	19.5
	SD	1.2	4.7	7.6	4.3	7.9	6
Total (Max score: 100)	Mean	1.9	32.3	49.0	68.6	50.0	50
	SD	3.0	8.4	11.2	9.8	15	11

Note: BPPV-IP: Primary/ideopathic BPPV, BPPV-MD: BPPV-VN: BPPV secondary to VN, BPPV secondaryto Meniere's disease, BPPV-UVP: BPPV secondary to unspecific vestibular pathology

Figure 4.1: *Mean percentage score across various domains of DHI in different subgroups*



Comparison of each domain of DHI in Figure 4.1 shows that functional domain was more affected followed by physical and emotional domain in the participants of Group II-VN, whereas in participants of Group II-MD, functional domain was maximally affected followed by emotional domain and physically domain. Unlike these two groups of participants, participants of the Group II-UVP and Group II-IP, physical domain was found to be more affected followed by the functional and emotional domain.

The scores on the various domains of WHOQOL-BREF were transformed as per the guideline provided by WHOQOL Group (2004). Lower score on the scale indicates poorer quality of life. Mean and SD values on various domains of WHOQOL-BREF for the two groups is shown in the Table 4.18. It can be observed from the table that the mean scores on WHOQOL-BREF were lower for Group II as compared to the

score of Group I indicating poorer general quality of life. Furthermore, it can be seen that, mean scores on WHOQOL- BREF was least in the participants of Group II-VN followed by the participants of Group II-MD, participants of Group II-UVP revealing worst affected general quality of life in individuals with BPPV secondary to VN. On further comparison of each domain of WHOQOL-BREF (Figure 4.2) it was observed that physical domain was more affected followed by social relationship, psychological and environmental domain in participants of group II-VN, Group II-UVP and Group II-IP. Among the participants of Group II-MD also physical domain was more affected but it was followed by psychological, social relationship and environmental domain among all the participants. In order to study if the scores obtained by different groups significantly vary from each other, Mann-Whitney- test U test was carried out and the results are shown in Table 4.19. It can be seen that the quality of life of participants of BPPV, primary as well as secondary was significantly lower than those of Group I.

Table 4.18: *Mean and SD values of various domain of WHOQOL-BREF in different subgroups*

Domains	**Score**	**Group I**	**BPPV II-MD**	**BPPV II-VN**	**BPPV II-UVP**	**BPPV II- IP**	**All groups combined**
Physical	Mean	89.2	51.0	47.8	57.5	60.8	52
	SD	7.5	9.6	14.7	18.5	15.4	14.5
Psychological	Mean	89	60.5	54.5	64.2	70.8	62.5
	SD	7.5	24	26	20.6	12.9	20.7
Social	Mean	89	59.2	52.2	61.5	64.0	59.2
Relationship	SD	7.5	11.4	13.3	15.5	11.8	12.6
Environmental	Mean	95.2	69	64.1	68.8	71.1	68
	SD	5.3	9.9	17.6	16.8	10.8	13.6

Figure 4.2: Mean transformed score across various domains of WHOQOL-BREF in different subgroups

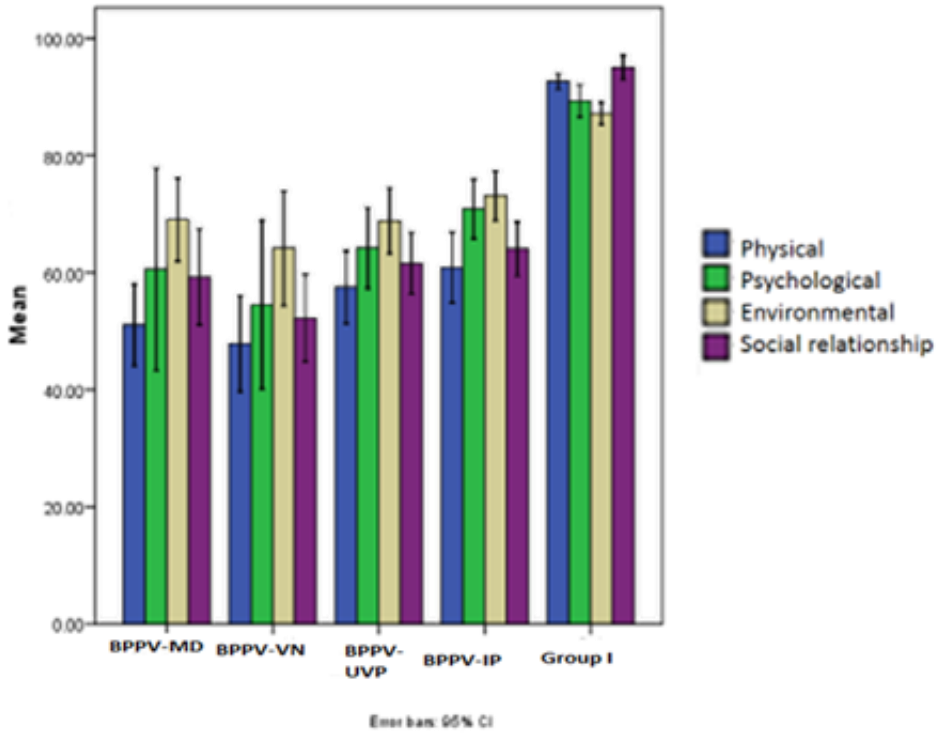


Table 4.19: *Results of Mann-Whitney U test comparing Group I and subgroups of Group II on DHI and WHOQOL-BREF*

Group Comparison		**Group I – Group II-IP**		**Group I – Group II-MD**		**Group I – Group II-VN**		**Group I – Group II-UVP**	
	Domains	Z	*p*	Z	*p*	Z	*p*	Z	*p*
DHI scale	Physical	3.5	0.00	4.5	0.00	4.9	0.00	3.5	0.00
	Emotional	4.5	0.00	4.9	0.00	5.1	0.00	4.5	0.00
	Functional	4.8	0.00	4.9	0.00	5.8	0.00	4.8	0.00
WHOQOL-BREF	Physical	4.1	0.01	4.1	0.01	4.1	0.01	4.1	0.01
	psychological	3.8	0.02	4.8	0.01	4.8	0.00	3.8	0.01
	Environmental	3.6	0.02	4.5	0.01	4.6	0.01	3.6	0.01
	social relationship	2.9	0.029	3.8	0.01	4.9	0.01	2.9	0.001

Comparison of self-perceived handicap and QOL between persons with primary BPPV and Secondary BPPV

Comparison of quality of life and self-perceived handicap was also done between persons with primary BPPV and those with secondary BPPV. Table 4.20 shows that participants of the Group II-VN were found to be differing significantly from the participants with BPPV-IP on all the domains of DHI. Similarly, participants of Group II-MD and Group II-UVP were differing from the participants with BPPV-IP except for the physical domain of DHI. However, on WHOQOL-BREF, participants with BPPV - MD and UVP did not differ significantly from participants with BPPV-IP. Only individuals with BPPV-VN differed from individuals with BPPV-IP on 'Social Relationship' domain of WHOQOL-BREF.

Table 4.*20 Results of Mann-Whitney U test comparing Primary and secondary BPPV on DHI and WHOQOL-BREF*

Group Comparison		**BPPV-IP-BPPV-MD**		**BPPV IP-BPPV VN**		**BPPV -IP Group II UVP**	
	Domains	Z	*p*	Z	*p*	Z	*p*
DHI scale	Physical	0.14	0.89	4.1	0.00	1.7	0.087
	Emotional	3.7	0.00	5.0	0.00	4.7	0.00
	Functional	2.8	0.005	5.4	0.00	3.9	0.00
WHOQOL-BREF	Physical	1.6	0.1	2.5	0.11	0.72	0.47
	Psychological	1.0	0.28	1.8	0.06	1.1	0.23
	Environmental	0.8	0.4	1.8	0.06	0.74	0.45
	social relationship	0.9	0.3	2.6	0.008	0.38	0.70

4.2.2 Self perceived handicap and Quality of Life in subgroups based on the results of vestibular test

As described in section 4.3.1 abnormal results on cVEMP were found in 72 % of the participants and unilateral weakness in 35 % of the participants of Group II. It has been observed that, individuals with secondary BPPV due to MD, VN or UVP may show abnormal responses on only cVEMP or on both cVEMP and caloric test. To investigate if the Quality of life (QOL) differs based on the pattern of abnormality on these test results, Group II was divided further into three subgroups, Group IIa, Group IIb, Group IIc. The criteria for subdivision and the number of participants in each group is given in Table 4.21

Table 4.21: *Criteria for subgrouping of Group II based on results of vestibular tests*

Groups ⇩ Test results ⇨	**Dix-Hallpike**	**cVEMP**	**Caloric test**	**N**
Group IIa	Abnormal	Normal	Normal	30
Group IIb	Abnormal	Abnormal	Normal	32
Group IIc	Abnormal	Abnormal	Abnormal	30

Self-Perceived handicap

Mean and SD values were computed for the total score of DHI as well as for each domain of DHI separately for each subgroups. As the number of questions covered under each domains are uneven, these mean values were converted into mean percentage score in order to compare one domain with other. Table 4.22 describes the absolute mean values and standard deviation for various domains of DHI scale among the groups of participants with BPPV for different subgroups. It can be seen from the

table that individuals of Group IIb and Group IIa had moderate self-perceived handicap whereas it was severe in individuals of Group IIc.

Table 4.22 *Mean and SD of DHI scores Group IIa, IIb and IIc*

Domains	**Groups**		**Mean**	**SD**	**Mean (%)**	**SD (%)**
DHI Physical	Group I		1.92	1.5	7.1	5.3
	Group II	IIa	13.2	2.9	48.4	10.8
		IIb	14.4	5.44	50.3	21.4
		IIc	20.0	6.0	62.2	22.1
DHI Emotional	Group I		.25	.67	1	1.8
	Group II	IIa	7.7	3.7	21	11.2
		IIb	14.2	5.8	38	17.
		IIc	20.1	5.8	53.6	19.8
DHI Functional	Group I		.82	1.2	2.8	4.7
	Group II	Gr IIa	11.5	4.75	35.3	15.2
		Gr IIb	18.7	7.7	50.7	23.3
		Gr IIc	25.5	5.9	66.3	22.3
DHI Total	Group I		1.9	3.09	1.9	3.0
	Group II	IIa	32.3	8.4	32.3	8.4
		IIb	46.5	14.9	46.5	14.9
		IIc	65.7	10.2	65.7	10.2

Figure 4.3: *Mean percentage score (%) across various domains of DHI for Group IIa, IIb and IIc*

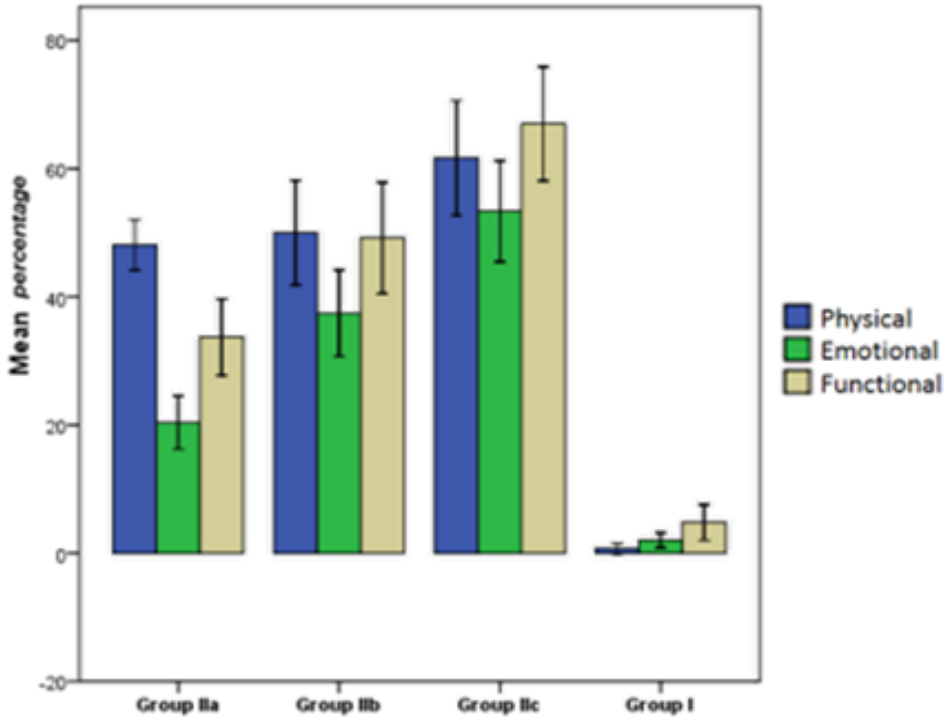


Figure 4.3 shows scores in percentage across three domains of DHI among the participants of Group I, Group IIa, Group IIb and Group IIc. It can be observed that participants of Group IIa had Physical domain to be maximally affected followed by functional and emotional domain whereas functional domain was found to be maximally affected followed by physical and emotional domain among the participants of Group IIb and Group IIc

Kruskal -Wallis test showed (refer Table 4.23) that there was a highly significant effect of group on DHI scores (total as well as scores of all domains). Pair-wise comparison was done using Mann-Whitney U test. It can be observed from Table 4.24 that DHI scores (total and all the domains) of Group IIa, Group IIb and Group IIc differed significantly from those of Group I.

Table 4.23 *Results of Kruskal-Wallis test comparing DHI scores of Group I, IIa, IIb and IIc*

Domains	**df**	**Chi-Square (X^2)**
DHI-Physical	03	92.1**
DHI- Emotional	03	103.4**
DHI- Functional	03	100.5**
DHI – Total	03	100.2**

* 0.05 level of significance

** 0.01 level of significance

Table 4.24: *Results of Mann- Whitney U test comparing DHI scores Group IIa, IIb and IIc with Group I*

Between Group comparison	**Group I –Group IIa**	**Group I – Group IIb**	**Group I –Group IIc**
Domains	Z value	Z value	Z value
DHI-Physical	4.1**	3.91**	3.91**
DHI- Emotional	3.51**	4.41**	3.91**
DHI- Functional	4.9**	4.2**	3.02**
DHI – Total	4.01**	3.91**	3.91**

* 0.05 level of significance

** 0.01 level of significance

Pairwise comparisons was done further using Mann-Whitney U test to compare scores of Group IIa, Group IIb and Group IIc. It can be observed from Table 4.25 that all the subgroups differed significantly on the total score of DHI and scores of all domain

among themselves except participants of Group IIa and Group IIb on physical domain.

Table 4.25: *Results of Mann-Whitney test comparing DHI score among Group IIa, IIb and IIc*

Between Group comparison	***Group IIa –Group IIb***	***Group IIa – Group IIc***	***Group IIb – Group IIc***
Domains	Z value	Z value	Z value
DHI-Physical	0.91	2.91**	3.01**
DHI- Emotional	2.91**	3.21**	2.91**
DHI- Functional	3.01**	3.1**	3.9**
DHI – Total	3.51**	3.91**	4.01**

* 0.05 level of significance

** 0.01 level of significance

General quality of life using WHOQOL-BREF among the participants of Group IIa, IIb II General QOL was assessed by computing the Mean and SD values for each domain of WHOQOL-BREF as well as the mean total score of WHOQOL-BREF for the participants of Group I, IIa, IIb and IIc. Table 4.26 depicts mean transformed scores and standard deviation for various domains of WHOQOL-BREF scale. It can be observed that score on WHOQOL-BREF was lower among the participants of all the clinical subgroups of Group II. Further, participants of Group IIc had lowest mean score on the domains as well as total score of WHOQOL-BREF as compared to participants of Group IIa and Group IIb

Table 4.26 *Mean and SD of transformed scores of Group I and Group IIa IIb and IIc on WHOQOL-BREF*

Domains	**Groups**		**Mean**	**SD**
WHOQOL	Group I		89.2	7.5
Physical	Group	IIa	70.8	12.9
	II	IIb	68.4	20
		IIc	50.3	23.3
WHOQOL	Group I		89	7.5
Psychological	Group	IIa	70.8	12.9
	II	IIb	68.4	20.5
		IIc	50	23.3
WHOQOL	Group I		89.2	7.57
Environmental	Group	IIa	70.8	12.95
	II	IIb	68.0	20.5
		IIc	50.0	23.3
WHOQOL Social relationship	Group I		95.2	5.3
	Group II	IIa	64.0	11.8
		IIb	59.6	16.0
		IIc	57.6	13.7
WHOQOL Total	Group I		98	3.18
	Group	IIa	96.9	10.24
	II	IIb	96.5	15.02
		IIc	85.5	9.66

Figure 4.4: *Mean transformed score across various domains of WHOQOL-BREF*

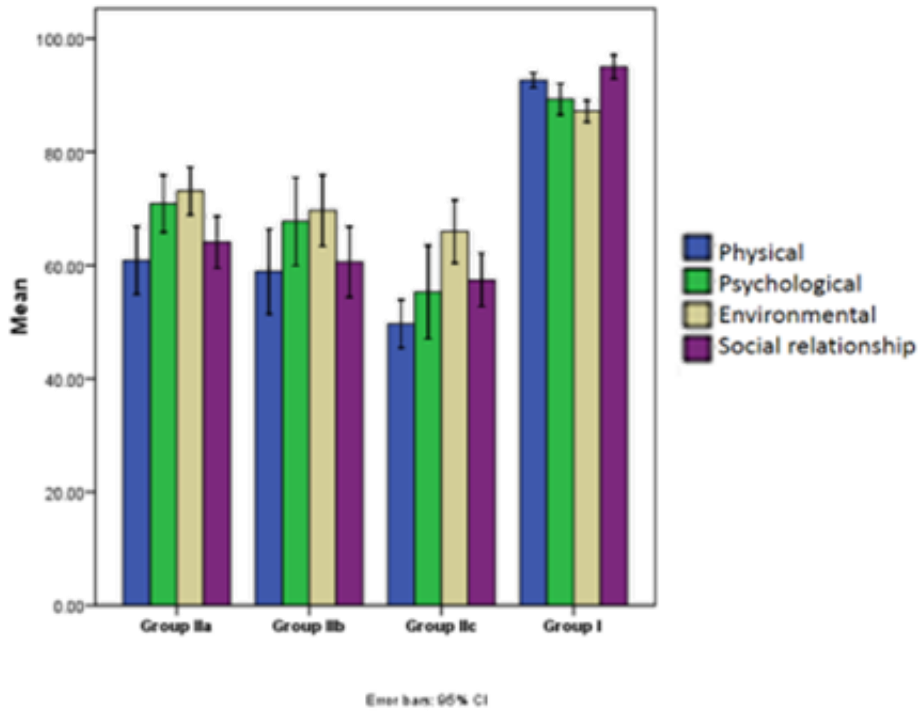


Figure 4.4 shows pattern of abnormality across five domains of WHOQOL-Brief among the participants of Group I, Group IIa, Group IIb and Group IIc. Overall, it can be observed that physical domain had lowest score across the participants of all the three subgroups (Group IIa, Group IIb & Group IIc) indicating maximally affected QOL in areas depicted by this physical domain. Social relationship was second maximally affected domain followed by psychological and environmental domain among the participants of Group IIb and Group IIa. Unlike these two subgroups, participants of Group IIc showed different pattern of abnormality across the domains of WHOQOL-BREF. In this group, subsequent to physical domain was psychological, social relationship and environmental respectively.

In order to compare general QOL among participants of Group I, IIa, IIb and IIc, Kruskal-Wallis test was applied. Results showed a significant effect of group on the total score of WHOQOL-BREF as well as scores of all the domains (Table: 4.27).

Pair-wise comparison was done using Mann-Whitney U test showed (refer Table 4.28) that participants of Group I differed significantly from the participants of Group IIa, Group IIb and Group IIc on total score of WHOQOL-BREF as well as its domains. Further comparison across the subgroups of Group II (Refer Table 4.29) showed that general quality of life did not differ significantly on WHOQOL-BREF between the participants of Group IIa and Group IIb. But Group IIc differed significantly from Group IIa as well as Group IIb on the total score, physical domain and psychological domain of WHOQOL-BREF.

Table 4.27: *Results of Kruskal-Wallis test comparing score of the WHOQOL-BREF among the participants of Group I and Group II*

Domains	**Df**	**Chi-Square (X^2)**
WHOQOL-Physical	03	77.01**
WHOQOL-Psychological	03	57.3**
WHOQOL- Environmental	03	47.4**
WHOQOL-Social Environmental	03	80.5**
WHOQOL-Total	03	67.1**

* 0.05 level of significance, ** 0.01 level of significance

Table 4.28*: Pair-wise comparison of Group IIa, IIb and IIc with Group I*

Between Group comparison	**Group I – Group IIa**	**Group I –Group IIb**	**Group I – Group IIc**
Domains	Z value	Z value	Z value
WHOQOL- QOL	-3.91**	-3.01**	-4.01**
WHOQOL-Physical	-3.01**	-3.34*	-3.21*
WHOQOL-Psychological	-3.7**	-3.9**	-3.9**
WHOQOL-Environmental	-2.0**	-2.0**	-3.1**
WHOQOL-Social relationship	-2.4**	-3.5**	-2.6**
WHOQOL-Total	-1.9**	-4.5**	-3.5**

* 0.05 level of significance, ** 0.01 level of significance

Table 4.29: *Results of Mann-Whitney U test comparing Group IIa, IIb and IIc on scores of WHOQOL-BREF*

Between Group comparison	**Group IIb – Group IIa**	**Group IIb – Group IIc**	**Group IIc – Group IIa**
Domains	Z value	Z value	Z value
WHOQOL-Physical	1.01	2.01*	3.01*
WHOQOL-Psychological	2.7**	2.7*	3.7**
WHOQOL-Environmental	1.0	1.0	0.30
WHOQOL-Social relationship	1.4	0.34	0.24
WHOQOL-Total	1.2	4.2**	3.2*

* 0.05 level of significance, ** 0.01 level of significance

4.3 Factors affecting self-perceived handicap and quality of life (QOL)

4.3.1. Effect of age on Self –Perceived Handicap and General Quality of Life

In the present research age range of the participants ranged from 40 to 70 years with a mean age being 50 years and a standard deviation of 12 years. In order to study the effect of age, participants of Group II were categorized into two age groups, 'young adults' and 'old adults'. 'Young adults' included forty-nine individuals who were less than 60 years of age and 'Old adults' included thirty eight individuals above 60 years of age. Table 4.30 depicts the Mean and SD DHI scores for Young adults and Old adults across Group IIa, IIb and IIs. It can be observed from Table 4.30 and that mean scores on physical domain and functional domain was higher in Old adults when compared to Young adults in all the three groups. Unlike the physical and functional domain, emotional domain did not show such trend between Young and Old adults.

Table 4.30: Mean and SD values for the DHI scale between young adults and old adults with BPPV. Table 4.31 shows Mean and SD values for various domains of

WHOQOL-BREF for young adults and old adults of Group IIa, IIb and IIc. It can be observed that 'Old Adults' had lower scores especially in the physical, psychological and social relationship domain when compared to 'Young Adult' Group, especially among the participants of Group IIa and Group IIb. The standard deviation was larger for Old Adults. Table 4.30: *Mean and SD values for the DHI scale between young adults and old adults with BPPV*

Groups			**Group IIa**		**Group IIb**		**Group IIc**	
Gender Groups			**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Number of Participants (N)			16	14	17	15	18	14
DHI	Physical	Mean and SD	12.15 (2.7)	14.35 (2.8)	14.25 (3.4)	14.60 (5.9)	18.5 (5.8)	21.6 (5.82)
		Mean (%)	43.3 %	51 %	51%	52 %	66 %	77%
	Emotional	Mean and SD	6.5 (4.0)	8.2 (3.5)	12.8 (7.1)	15.1 (5.0)	19.4 (7.3)	19.6 (4.8)
		Mean (%)	18%	22%	35%	41%	53%	54%
	Functional	Mean and SD	8.7 (4.5)	14.2 (3.5)	16.1 (6.9)	20.3 (7.9)	24.1 (7.3)	26.7 (4.9)
		Mean (%)	24%	39%	44%	56%	66%	72%
	Total	Mean & SD	27 (7.8)	36.8 (5.7)	42.4 (13.8)	49.0 (15.5)	62.0 (12.2)	67.3 (9.5)

Table 4.31: *Mean and SD values for the WHOQOL-BREF scale between young adults and old adults with BPPV*

Groups			**Group IIa**		**Group IIb**		**Group IIc**	
Age groups			**Young Adults**	**Old Adults**	**Young Adults**	**Old Adults**	**Young Adults**	**Old Adults**
Number of Participants (N)			16	14	17	13	18	14
WHOQOL-BREF	Physical	Mean	62.50	59.18	61.14	50.51	46.21	51.62
		SD	(15.52)	(15.76)	(19.89)	(22.15)	(10.89)	(7.20)
	Psychological	Mean	73.57	68.15	70.30	61.84	52.74	52.65
		SD	(15.67)	(9.33)	(19.37)	(24.95)	(24.12)	2.14)
	Social Relationship	Mean	69.47	58.63	60.37	57.14	54.65	61.07
		SD	(13.10)	(7.6)	(11.13)	(23.37)	(12.40)	(12.16)
	Environmental	Mean	74.62	71.59	69.38	68.12	62.31	70.83
		SD	(11.43)	(10.48)	(9.91)	(28.01)	(13.75)	(16.64)
	Total score	Mean	99.94	94.02	98.77	88.78	85.32	86.54
		SD	(11.45)	(8.23)	(15.25)	(19.89)	(10.34)	(8.46)

To investigate if the difference in scores were statistically significant, Mann-Whitney U test was carried out. It can be observed from Table 4.32 that there was no significant difference between the scores of Young adults and Old adults across all the domains of DHI and WHOQOL-BREF except for the psychological and social relationship domain of the WHOQOL-BREF of Group IIa.

Table 4.32: *Results of Mann-Whitney U test comparing the scores of two age groups*

Group		**Group IIa**		**Group IIb**		**Group IIc**	
		Z Value	***p* value**	**Z Value**	***p* value**	**Z Value**	***p* value**
DHI	Physical	0.39	0.71	0.76	0.47	1.6	0.16
	Emotional	0.98	0.37	0.092	0.92	0.24	1.1
	Functional	0.42	0.65	0.06	1.0	0.64	0.54
	Total	0.2	0.14	0.13	0.19	0.65	0.15
WHOQOL-BREF	Physical	0.55	0.60	0.82	0.42	1.6	0.1
	Psychological	2.1	0.035	1.0	0.32	0.04	0.96
	Environmental	0.56	0.57	0.54	0.59	1.3	0.19
	Social Relationship	2.06	0.03	0.20	0.85	1.1	0.24
	Total	0.25	0.15	0.29	0.17	2.01	0.04

4.3.2 Effect of Gender on Self perceived Handicap and General Quality of Life

In order to study the effect of gender on self-perceived handicap, scores on DHI were analyzed as per the gender of an individual among the participants of Group IIa, Group IIb and Group IIc. Table 4.33 shows the mean and SD of DHI scores for males and females for Group IIa, IIb and IIc. It can be observed from Table 4.33 that the score across all the domains of DHI was higher among the female participants when compared to scores of male participants. Physical domain was more affected

followed by functional domain and emotional domain in both male as well as female participants.

Table 4.33 *Mean SD of DHI scores for male and female participants*

Groups			**Group IIa**		**Group IIb**		**Group IIc**	
Gender Groups			**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Number of Participants (N)			16	14	16	14	17	15
DHI	Physical	Mean SD	12.15 (2.7)	14.35 (2.8)	14.25 (3.4)	14.60 (5.9)	18.5 (5.8)	21.6 (5.82)
		Mean (%)	43.3%	51 %	51%	52 %	66 %	77%
	Emotional	Mean SD	6.5 (4.0)	8.2 (3.5)	12.8 (7.1)	15.1 (5.0)	19.4 (7.3)	19.6 (4.8)
		Mean (%)	18%	22%	35%	41%	53%	54%
	Functional	Mean SD	8.7 (4.5)	14.2 (3.5)	16.1 (6.9)	20.3 (7.9)	24.1 (7.3)	26.7 (4.9)
		Mean (%)	24%	39%	44%	56%	66%	72%
	Total	Mean SD	27 (7.8)	36.8 (5.7)	42.4 (13.8)	49.0 (15.5)	62.0 (12.2)	67.3 (9.5)

Table 4.34 shows Mean and SD across the domains of WHOQOL-BREF for male and female participants. It can be observed from the table that there is no consistent pattern of score in female versus male participants on WHOQOL-BREF. Comparison of scores of male and female participants for the scores of DHI and WHOQOL-BREF was done using Mann-Whitney U test. The results given in Table 4.35 shows that there was no significant difference between male and female participants on scores of DHI as well as WHOQOL-BREF except for the psychological domain of WHOQOL-

BREF. A significant difference between the two genders was observed for scores of psychological domain on WHOQOL-BREF of all three clinical groups

Table 4.34 *Mean and SD of WHOQOL-BREF scores for male and female participants*

Groups			**Group IIa**		**Group IIb**		**Group IIc**	
Gender Groups			**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Number of Participants (N)			16	14	16	14	17	15
WHOQ OL-BREF	Physical	Mean SD	60.1 (15.4)	61.4 (15.9)	61.8 (22.5)	57.1 (19.5)	47.8 (9.9)	48.9 (10)
	Psychological	Mean SD	74.4 (16.5)	67.7 (8.1)	57.6 (20)	74.9 (18.4)	57.6 (20)	74.9 (18.4)
	Social Relationship	Mean SD	72.9 (11.4)	73.2 (10.7)	71.3 (11.7)	67.7 (19.9)	71.3 (11.7)	67.7 (19.9)
	Environmental	Mean SD	64.5 (15)	60.5 (12.31)	56.9 (18.2)	61.3 (16)	56.9 (18.2)	61.3 (16)
	Total Score	Mean SD	90.1 (8.5)	94.8 (9.2)	93.2 (13)	98.5 (16)	82.6 (8.9)	89.4 (9.0)

Table 4.35 *Results of Mann -Whitney U test comparing scores of males and females*

Group		**Group IIa**		**Group IIb**		**Group IIc**	
DHI	**Domains**	**Z**	***p***	**Z**	***p***	**Z**	***p***
	Physical	2.3	0.02	0.55	0.64	1.3	0.1
	Emotional	1.4	0.15	0.66	0.52	0.4	0.97
	Functional	3.2	0.01	0.4	0.14	0.8	0.4
	Total	1.9	0.06	0.6	0.49	0.64	0.5
WHOQOL-BREF	Physical	0.3	0.7	0.2	0.833	0.07	0.97
	Psychological	2.1	0.03	2.6	0.007	1.9	0.05
	Social Re.	1.7	0.08	0.6	0.5	1.2	0.23
	Environmental	0.07	0.8	0.2	0.8	0.8	0.7
	Total	2.1	0.04	2.4	0.03	1.6	0.07

4.3.3 Association of duration of dizziness with self-perceived handicap and general quality of life

Duration of dizziness was documented in minutes as reported by a client. The duration of dizziness varied from 30 seconds to 4 hours with a mean of 30.5 minutes. Association of duration of dizziness with self-perceived handicap and general quality of life was analyzed using Kendell's Tau-b correlational analysis. Table 4.36 describes the level of correlation along with the level of significance. It can be seen from the table that there is a low but significant correlation between total score of

DHI and duration of dizziness among the participants of Group IIa and Group IIb. Emotional domain of DHI showed a significant moderate association with duration of dizziness among the participants of Group IIb and Group IIc. There was no association between duration of dizziness and general quality of life (QOL) assessed using WHOQOL-BREF except for social relationship among the participants of Group IIa.

Table 4.36: *r value and p value between duration of dizziness and score on DHI & WHOQOL*

Groups		**Group IIa (N = 30)**		**Group IIb (N =30)**		**Group IIc (N =32)**	
DHI	Domains	r Value	*p* Value	r Value	*P* Value	r Value	*p* Value
	Physical	0.23	0.11	o.34	0.15	0.26	0.34
	Emotional	0.50	0.44	0.24	0.007	0.56	0.021
	Functional	0.040	0.95	0.1	0.677	0.08	0.56
	DHI total	0.58	0.43	0.3	0.03	0.38	0.01
WHOQOL-BREF	Physical	0.50	0.8	0.50	0.06	0.3	0.54
	Psychological	0.08	0.5	0.08	0.49	0.39	0.31
	Social Relationship	0.38	0.9	0.38	0.05	0.33	0.21
	Environmental	0.25	0.6	0.26	0.36	0.31	0.12
	Total	0.2	0.5	0.5	0.054	0.4	0.07

4.3.4 Association of frequency of dizziness with self-perceived handicap and General QOL

Table 4.37 *r value and p value between Frequency of dizziness and score on DHI & WHOQOL for the participants of Group II*

Groups		**Group IIa (N = 30)**		**Group IIb (N =30)**		**Group IIc (N =32)**	
DHI	**Domains**	**r Value**	***p* Value**	**r Value**	***p* Value**	**r Value**	***p* Value**
	physical	0.2	0.05	0.42	0.007	0.42	0.15
	Emotional	0.50	0.008	0.54	0.18	0.150	0.003
	Functional	0.58	0.06	0.51	0.53	0.54	0.00
	DHI total	0.67	0.01	0.53	0.006	0.67	0.00
WHOQOL-BREF	Physical	0.42	0.04	0.23	0.064	0.34	0.00
	Psychological	0.39	0.049	0.50	0.142	0.40	0.02
	Social Relationship	0.36	0.043	0.08	0.382	0.39	0.005
	Environmental	0.31	0.049	0.38	0.136	0.34	0.026
	Total	0.35	0.050	0.31	0.03	0.45	0.044

Frequency of dizziness was computed based on the occurrence of dizziness in a day as reported by an individual. The frequency of dizziness ranged from 2 times to 8 times per day with a mean of 4 times a day. Table 4.37 indicates results of Kendell's tau-'b' correlation analysis, Significant moderate correlation was observed between frequency of dizziness and DHI scores among the participants of Group IIa, IIb and IIc. No correlation was observed between frequency of dizziness and scores of WHOQOL –BREF among participants of Group IIa but there was a low significant correlation between frequency of dizziness and general quality of life among the participants of Group IIb and IIc.

4.3.5 Association of associated hearing loss with self perceived handicap and general quality of life

Kendell's Tau 'b' correlation coefficient was used to study if there is any association between pure tone average and the scores of DHI as well as WHOQOL-BREF in individuals with BPPV. It can be observed from Table 4.38 that there was no significant correlation between PTA and any of the domains of DHI among all the groups. However, there was a significant correlation between pure tone average and general quality of life.

Table 4.*38 r value and p value between degree of hearing loss and score on DHI & WHOQOL for the participants of Group II*

Groups		**Group IIa (N = 30)**		**Group IIb (N =30)**		**Group IIc (N =32)**	
DHI	**Domains**	**r Value**	***p* Value**	**r Value**	***p* Value**	**r Value**	***p* Value**
	physical	0.4	0.67	0.52	0.72	0.23	0.52
	Emotional	0.65	0.83	0.34	0.18	0.10	0.36
	Functional	0.71	0.64	0.61	0.53	0.4	0.54
	DHI total	0.54	0.75	0.31	0.61	0.7	0.31
WHOQOL-BREF	Physical	0.32	0.065	0.4	0.04	0.35	0.04
	Psychological	0.225	0.22	0.56	0.001	0.56	0.01
	Social Relationship	0.46	0.02	0.38	0.0382	0.39	0.05
	Environmental	0.31	0.09	0.48	0.005	0.48	0.05
	Total	0.58	0.020	0.51	0.01	0.56	0.01

Overall it can be summarized that more number of participants with BPPV report abnormality on pure tone audiometry, spontaneous nystagmus test, gaze test, positional nystagmus test and caloric test. Further, abnormal results are also observed for the amplitude of cVEMP among persons with BPPV as compared to normal healthy control. On assessment of self-perceived handicap and general QOL, it was found that self-perceived handicap as well as general QOL is affected more in persons with BPPV secondary to VN followed by MD, UVP than persons with primary BPPV. On assessment of self-perceived handicap and general QOL as per the extent of abnormality on vestibular tests, self-perceived handicap and general quality of life was found to be more in participants with BPPV having abnormal responses on both cVEMP as well as caloric test than participants with abnormal responses on only cVEMP. Least self-perceived handicap and general quality of life was observed in participants with BPPV who had no abnormality on either of the cVEMP or caloric test. Similarly, among the various factors that may have an effect on DHI and WHOQOL-BREF, frequency of dizziness has been found to have more effect on self-perceived handicap than duration of dizziness. Whereas associated hearing loss has not been observed to have an effect on self-perceived handicap but it effects general quality of life.