

Gür, Binkhamis, Kluk (2022)

MS & Audio-Vestibular System: Systematic Review

Supplement

Section I: Literature Search Strategy

Database searched: Scopus

Date of coverage: 2000 to November 2021

Search undertaken: August 2020, September 2020, February 2021, November 2021

((TITLE-ABS-KEY("multiple sclerosis")AND (hearing OR auditory OR "hearing loss" OR "auditory function" OR "hearing dysfunction")) OR (TITLE-ABS-KEY("multiple sclerosis") AND (dizziness OR vestibular OR vertigo OR equilibrium OR balance OR balanced OR "vestibular function")

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Database searched: Pubmed**Date of coverage: 2000 to November 2021****Search undertaken: August 2020, September 2020, February 2021, November 2021**

("multiple sclerosis"[MeSH Terms] AND ("auditorially"[All Fields] OR "auditory"[All Fields] OR ("hearing"[MeSH Terms] OR "hearing"[All Fields] OR "hearings"[All Fields]) OR "hearing loss"[All Fields] OR "hearing" [All Fields] OR "auditory function"[All Fields]) OR ("multiple sclerosis"[MeSH Terms] AND ("vestibular"[All Fields] OR ("dizziness"[MeSH Terms] OR "dizziness"[All Fields] OR "dizzy"[All Fields] OR "vertigo"[MeSH Terms] OR "vertigo"[All Fields]) OR ("vertigo"[MeSH Terms] OR "vertigo"[All Fields] OR "vertigos"[All Fields] OR "vertigoes"[All Fields]) OR ("equilibrium"[All Fields] OR "equilibriums"[All Fields]) OR ("balance"[All Fields] OR "balanced"[All Fields] OR "balances"[All Fields] OR "balancing"[All Fields]) OR "vestibular function"[All Fields]) AND

Translations**Multiple Sclerosis[MeSH Terms]:** "multiple sclerosis"[MeSH Terms]**auditory:** "auditorially"[All Fields] OR "auditory"[All Fields]**hearing:** "hearing"[MeSH Terms] OR "hearing"[All Fields] OR "hearings"[All Fields]**multiple sclerosis[MeSH Terms]:** "multiple sclerosis"[MeSH Terms]**dizziness:** "dizziness"[MeSH Terms] OR "dizziness"[All Fields] OR "dizzy"[All Fields] OR "vertigo"[MeSH Terms] OR "vertigo"[All Fields]**vertigo:** "vertigo"[MeSH Terms] OR "vertigo"[All Fields] OR "vertigos"[All Fields] OR "vertigoes"[All Fields]**equilibrium:** "equilibrium"[All Fields] OR "equilibriums"[All Fields]**balance:** "balance"[All Fields] OR "balanced"[All Fields] OR "balances"[All Fields] OR "balancing"[All Fields]

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Database searched: Web of Science**Date of coverage: 2000 to November 2021****Search undertaken: August 2020, September 2020, February 2021, November 2021**

Databases= WOS, BCI, BIOSIS, CCC, DRCI, DIIDW, KJD, MEDLINE, RSCI, SCIELO, ZOOREC, Timespan=2000-2021

- #1 TS=("multiple sclerosis")
- #2 TS=(auditory OR audio OR "auditory function" OR "auditory system")
- #3 TS=(hear* OR hearing OR "hearing loss")
- #4 #2 OR #3
- #5 #4 AND #1
- #6 TS=(vestibular OR vestibul* OR "vestibular dysfunction" OR "vestibular system")
- #7 TS=(vertigo)
- #8 TS=(dizzy OR dizziness)
- #9 TS=(balance OR balanced OR balances OR balanc*)
- #10 #6 OR #7 OR #8 OR #9
- #11 #1 AND #10
- #12 #5 OR #11 AND

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Database searched: NICE

Date of coverage: 2000 to November 2021

Search undertaken: August 2020, September 2020, February 2021, November 2021

("multiple sclerosis") AND (hearing OR auditory OR "hearing loss" OR "auditory function" OR hear* OR "hearing dysfunction") OR (("multiple sclerosis") AND (dizziness OR vestibular OR vertigo OR equilibrium OR balance OR balanced OR "vestibular function"))

Section II: Assessment of Bias

Table S1: Assessment of Bias for case-control studies according to RoBANs

Year	Author	Selection of participants	Confounding Variables	Measurement of Exposure	Blinding of the Outcome of the Assessment	Incomplete Outcome of Data	Selective Outcome Reporting
2002	Japaridze et al. ^[1]	?	+	+	-	+	+
2002	Sartucci and Logi ^[2]	+	+	+	-	+	+
2004	Alpini et al. ^[3]	-	?	+	-	+	+
2005	Aidar and Suzuki ^[4]	+	+	+	-	+	-
2007	Patkó et al. ^[5]	?	-	+	-	+	+
2008	Zeigelboim et al. ^[6]	?	+	+	-	+	+
2009	Lima et al. ^[7]	?	?	+	-	+	+
2010	Lewis et al. ^[8]	+	+	+	-	+	+
2010	Matas et al. ^[9]	+	+	+	-	+	+
2012	Doty et al. ^[10]	-	+	+	-	+	+
2012	Saberi et al. ^[11]	+	+	+	-	+	+
2013	Gabelić et al. ^[12]	+	+	+	-	+	+
2013	Harirchian et al. ^[13]	+	+	+	-	+	+
2014	Valadbeigi et al. ^[14]	+	+	+	-	+	+
2015	Pokryszko-Dragan et al. ^[15]	+	+	+	-	+	+
2018	Doty et al. ^[16]	-	+	+	-	+	+
2018	Kavasoglu et al. ^[17]	+	?	+	-	+	+
2018	Koura et al. ^[18]	+	+	+	-	+	+
2019	Elbeltagy et al. ^[19]	-	+	+	-	+	+
2021	Rishiq et al. ^[20]	?	+	+	-	+	+
2021	Srinivasan et al. ^[21]	+	+	+	-	+	+
2021	Elmoazen et al. ^[22]	+	+	+	-	+	+

Green “+” = low risk of bias, red “-” = high risk of bias, yellow “?” = unclear risk of bias.

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Table S2: Risk of bias assessment of cohort studies by the Newcastle-Ottawa Quality Assessment form for cohort studies.

Year	Author	Representativeness of exposed cohort	Selection of non-exposed cohort	Ascertainment of exposure	Outcome of interest not present at the beginning	Comparability of cohorts/confounders	Assessment of the outcome	Follow-up Length	Adequacy of follow-up of cohorts	Study quality
2002	Versino et al. ^[23]	*	n/a	*	*	n/a	-	n/a	*	?
2008	Burina et al. ^[24]	-	n/a	*	n/a	-	-	-	-	?
2009	Eleftheriadou et al. ^[25]	*	-	*	*	*	-	*	*	Poor
2010	Degirmenci et al. ^[26]	*	-	*	*	*	*	*	*	Good
2016	Kaytanci et al. ^[27]	-	-	*	-	*	-	*	*	Poor
2019	Di Mauro et al. ^[28]	*	-	*	*	*	-	*	*	Good

* = low risk of bias, '-' = high risk of bias, "n/a" = the criteria does not apply to the paper, "?" = unknown quality of the paper due to the presence of "n/a" criteria.

Table S3: Risk of bias assessment of cross-sectional studies by the Newcastle-Ottawa Quality Assessment form which is adapted for cross-sectional studies.

Year	Author	Representativeness of the sample	Sample Size	Non-respondents	Ascertainment of exposure (risk factor)	Comparability of groups/confounders	Assessment of the outcome	Statistical test	Study quality
2015	Parsa et al. ^[29]	-	-	-	*	*	-	*	Poor
2020	Yang and Liu ^[30]	*	-	*	*	*	-	*	Good
2020	Inojosa et al. ^[31]	*	-	*	*	*	-	*	Good
2020	Inojosa et al. ^[32]	*	-	*	*	*	-	*	Good
2021	Delphi et al. ^[33]	-	-	*	*	*	-	*	Good
2021	Cochrane et al. ^[34]	*	-	*	*	*	-	*	Good
2021	Cochrane et al. ^[35]	*	-	*	*	*	-	*	Good

* = low risk of bias, '-' = high risk of bias.

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Section III: Multiple Sclerosis and Auditory Function

Table S4. Characteristics of studies examining the effects of MS on auditory function

Test Battery	Author (Year)	Study Type	Sample Size		PwMS Mean Age (years)	PwMS Age range (Years)	% Female	MS Type (sample size)	MS Duration Mean (range) years	Results of PwMS compared to controls / normative data	
			PwMS	Controls							
ABR	Japaridze et al. (2002) ^[11]	Case-Control	40	33	30.5	18-57	77.5	?	?	65% Abnormal	
	Versino et al. (2002) ^[23]	Cohort	65	18	35.5	19-61	?	?	?	37.5% Abnormal	
	Burina et al. (2008) ^[24]	Cohort	60	NA	37.2	?	68.3	RRMS	?	95% Abnormal	
	Eleftheriadou et al. (2009) ^[25]	Cohort	46	40	40	20-66	45.6	RRMS	4.6	26% Abnormal	
	Lima et al. (2009) ^[7]	Case-control	25	NA	42.6 (female) 38 (male)	33-53 (female) 24-56 (male)	64.0	RRMS (14), PPMS (8), Unspecified Progressive (3)	?	?	30% Abnormal
	Matas et al. (2010) ^[9]	Case-control	25	25	34.88	25-55	76.0	RRMS	4.25 (?)	?	Significantly different
	Saberi et al. (2012) ^[11]	Case-control	60	38	29.9	?	73.3	?	3.2 (?)	?	20% Abnormal
	Pokryszko-Dragan et al. (2015) ^[15]	Case-control	86	40	39.55	19-60	72.0	?	8.57 (1-30)	?	Significantly different
	Kaytancı et al. (2016) ^[27]	Cohort	20	20	31.3	?	55.0	?	?	?	Significantly different
	Di Mauro et al. (2019) ^[28]	Cohort	40	40	37	18-50	60.0	RRMS	0.8 (0.8-2)	?	No difference
	Delphi et al. (2021) ^[33]	Cross-sectional	25	25	31.43	18-45	72.0	?	?	?	Significantly different
	Rishiq et al. (2021) ^[20]	Case-control	11	9	49.5	34-68	72.7	RRMS (9), PPMS (1), SPMS (1)	11.9 (2-30)	?	Significantly different at high click rate
Srinivasan et al. (2021) ^[21]	Case-control	45	45	31.77	18-50	73.3	RRMS	6.1 (5.37)	?	Significantly different and 55.56 % abnormal	
PTA	Lewis et al. (2010) ^[8]	Case-control	47	49	51.4	21-65	57.7 RRMS, 28.6 SPMS	RRMS (26), SPMS (21)	RRMS: 12.6 (2-43) SPMS: 23.3 (8-50)	?	Worse thresholds
	Doty et al. (2012) ^[10]	Case-control	73	73	Males: 45.24 Females: 45.6	?	71.2	RRMS (57), PPMS (3), SPMS (6), Unspecified (7)	Males: 7.36 (?) Females: 7.84 (?)	?	No significant difference
	Saberi et al. (2012) ^[11]	Case-control	60	38	29.9	?	73.3	?	3.2 (?)	?	Worse thresholds in female PwMS
	Di Mauro et al. (2019) ^[28]	Cohort	40	40	37	18-50	60.0	RRMS	0.8 (0.8-2)	?	No significant difference
	Srinivasan et al. (2021) ^[21]	Case-control	45	45	31.77	18-50	73.3	RRMS	6.1 (5.37)	?	Significantly different
TEOAEs & DPOAEs	Saberi et al. (2012) ^[11]	Case-control	60	38	29.9	?	73.3	?	3.2 (?)	?	No significant difference
	Kaytancı et al. (2016) ^[27]	Cohort	20	20	31.3	?	55.0	?	?	?	No significant difference
	Di Mauro et al. (2019) ^[28]	Cohort	40	40	37	18-50	60.0	RRMS	0.8 (0.8-2)	?	Significantly lower

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Table S4 continued: Characteristics of studies examining the effects of MS on auditory function

Test Battery	Author (Year)	Study Type	Sample Size		PwMS Mean Age (years)	PwMS Age range (Years)	% Female	MS Type (sample size)	MS Duration Mean (range) years	Results of PwMS compared to controls / normative data
			PwMS	Controls						
WDS	Lewis et al. (2010) ^[8]	Case-control	47	49	51.4	21-65	57.7 RRMS, 28.6 SPMS	RRMS (26), SPMS (21)	RRMS: 12.6 (2-43) SPMS: 23.3 (8-50)	No significant difference
	Valadbeigi et al. (2014) ^[14]	Case-control	26	26	28.9	18-40	?	RRMS	?	Lower scores PwMS
	Elbeltagy et al. (2019) ^[19]	Case-control	20	20	37.6	30-50	?	RRMS	?	Significantly lower
DPST	Valadbeigi et al. (2014) ^[14]	Case-control	26	26	28.9	18-40	?	RRMS	?	Significantly different
GIN	Valadbeigi et al. (2014) ^[14]	Case-control	26	26	28.9	18-40	?	RRMS	?	Significantly different
	Elbeltagy et al. (2019) ^[19]	Case-control	20	20	37.6	30-50	?	RRMS	?	Significantly different
CAEP	Japaridze et al. (2002) ^[11]	Case-Control	40	33	30.5	18-57	77.5	?	?	30% Abnormal
	Matas et al. (2010) ^[9]	Case-control	25	25	34.88	25-55	76.0	RRMS	4.25 (?)	16% Abnormal

Abbreviations: PTA= Pure Tone Audiometry, ABR= Auditory Brainstem Response, OAE= Oto-acoustic Emissions, TEOAE= Transient Evoked Oto acoustic emission, DPOAE= Distortion Product Oto acoustic Emissions, CAEP= Cortical Auditory Evoked Potentials, SCP= Slow Cortical Potentials, GIN= Gaps in Noise test, WDS= Word Discrimination Scores, DPST= Duration pattern sequence test, MS= Multiple Sclerosis, PwMS = Persons with Multiple Sclerosis, ? = not reported.

Cells shaded in grey represent test results that were abnormal or showed a difference between PwMS and Controls

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Extracted Pure Tone Audiometry Thresholds and Auditory Brainstem Response Results

Table S5: Pure Tone Audiometry Thresholds

Author (Year)	Group	Test Ear	PTA Threshold Per Frequency (Hz)													
			125		250		500		1000		2000		4000		8000	
			\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
Doty et al. (2012) ^[10]	Male PwMS	Average Across Ears	Not Tested		15.87	5.39	14.05	5.94	12.52	7.43	12.79	8.97	20.03	11.71	17.02	17.26
	Male Controls			14.35	8.24	15.90	8.68	15.53	8.58	17.74	8.93	22.77	16.08	20.23	22.49	
	Female PwMS			12.85	6.88	12.49	6.50	12.05	6.59	14.62	7.19	15.65	8.97	13.28	12.38	
	Female Controls			11.28	7.77	12.52	7.60	10.45	6.82	11.62	8.17	13.92	8.79	12.65	12.60	
Di Mauro et al. (2019) ^[28]	PwMS	Right	10.30	1.60	10.10	0.08	10.10	0.08	10.40	1.10	11.10	1.70	10.80	1.80	13.00	2.60
	Controls	Right	10.90	1.40	10.80	1.60	11.00	1.90	10.80	2.30	11.00	1.20	11.90	2.40	13.90	2.40
	PwMS	Left	10.30	1.70	10.90	1.20	10.40	1.90	10.40	1.30	10.80	1.10	11.40	1.70	12.50	2.20
	Controls	Left	10.90	1.40	10.80	1.60	11.00	1.30	10.90	2.10	11.10	1.90	11.90	2.80	13.90	2.40
Srinivasan et al. (2021) ^[21]	PwMS	Average Across Ears	Not Tested		12.22	6.40	13.11	5.92	13.61	5.90	12.55	7.19	13.66	8.06	16.16	9.08
	Controls			8.94	5.05	9.50	4.17	9.88	3.82	9.50	5.45	10.88	5.83	12.05	5.89	

Abbreviations:

PwMS = Persons with Multiple Sclerosis, PTA = Pure Tone Audiometry, \bar{x} = Mean, SD = Standard Deviation

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Table S6: Auditory Brainstem Response Parameters and Results

Author (Year)	Click Polarity - Transducer	ABR Parameters				Group	Test Ear	Peak Latency (ms)						Interpeak Latencies (ms)						Peak Amplitude (μ V)			
		PR	PL	Ave.	BP Filter			I	III	V	I-III		III-V		I-V		I		V				
											\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}
Lima et al. (2009) ^[7]	Rarefaction - TDH 39 Headphone	13.10	60 dB SL*	1024	100- 3000	PwMS	Right	1.50	0.16	3.63	0.30	5.56	0.40	2.13	0.22	1.93	0.31	4.06	0.33	?	?	?	?
							Left	1.53	0.20	3.63	0.30	5.64	0.43	2.10	0.31	2.01	0.29	4.11	0.39	?	?	?	?
Matas et al. (2010) ^[9]	Rarefaction - TDH 39 Headphone	19.90	80 dB nHL	2000	100- 3000	PwMS	Average Across Ears	1.53	0.13	3.72	0.31	5.78	0.37	2.21	0.26	2.03	0.27	4.26	0.35	?	?	?	?
						Controls	1.53	0.07	3.57	0.09	5.50	0.45	2.04	0.06	1.98	0.08	4.03	0.06	?	?	?	?	
Pokryszko- Dragan et al. (2015) ^[15]	? - Earphone unspecified	20.30	65 dB SL*	200	150- 3000	PwMS	Right	1.72	0.19	3.88	0.33	5.81	0.81	2.18	0.19	2.00	0.30	4.19	0.39	0.29	0.18	0.37	0.20
						Controls	1.70	0.14	3.85	0.16	5.73	0.23	2.14	0.12	1.87	0.18	4.02	0.20	0.30	0.10	0.46	0.19	
						PwMS	Left	1.68	0.12	3.87	0.17	5.77	0.73	2.19	0.16	1.96	0.30	4.15	0.34	0.32	0.14	0.40	0.24
						Controls	1.69	0.13	3.83	0.12	5.70	0.21	2.13	0.14	1.87	0.17	4.00	0.19	0.30	0.14	0.44	0.16	
Kaytancı et al. (2016) ^[27]	? - TDH 39 Headphone	13.00	70 dB nHL	1500	2000- 4000	PwMS	Right	2.03	0.27	4.36	0.49	6.26	0.35	2.33	0.49	1.90	0.28	4.23	0.42	?	?	?	?
						Controls	1.45	0.30	3.52	0.31	5.38	0.53	2.07	0.44	1.85	0.48	3.92	0.53	?	?	?	?	
						PwMS	Left	1.86	0.24	4.41	0.39	6.25	0.43	2.54	0.34	1.84	0.20	4.38	0.43	?	?	?	?
						Controls	1.47	0.24	3.40	0.43	5.39	0.46	1.92	0.48	1.99	0.53	3.91	0.47	?	?	?	?	
Delphi et al. (2021) ^[33]	Rarefaction - ?	9.00	70 dB nHL	?	30- 3000	PwMS	Right	1.89	0.11	4.25	0.14	6.32	0.13	2.30	0.11	2.21	0.09	4.48	0.13	?	?	?	?
						Controls	1.87	0.14	4.01	0.13	5.79	0.14	2.17	0.09	1.99	0.13	4.12	0.11	?	?	?	?	
						PwMS	Left	1.80	0.15	4.30	0.15	6.19	0.14	2.29	0.08	2.19	0.14	4.51	0.11	?	?	?	?
						Controls	1.79	0.11	3.96	0.13	5.87	0.15	2.15	0.14	1.96	0.08	4.09	0.14	?	?	?	?	
Srinivasan et al. (2021) ^[21]	Rarefaction - Insert earphones	21.10	80 dB nHL	1500	100- 3000	PwMS	Average Across Ears	1.44	0.18	3.61	0.40	5.63	0.73	2.17	0.38	2.03	0.50	4.19	0.70	?	?	?	?
		Controls				1.43	0.16	3.48	0.19	5.30	0.24	2.04	0.17	1.82	0.18	3.86	0.21	?	?	?	?		
		80.10				PwMS	Average Across Ears	?	?	?	?	6.12	0.72	?	?	?	?	?	?	?	?	?	
		Controls				?	?	?	?	5.76	0.27	?	?	?	?	?	?	?	?	?	?		

Abbreviations:

PR = Presentation Rate, PL = Presentation Level, Ave. = Number of Averages, BP = Band Pass, \bar{x} = Mean, SD = Standard Deviation, dB SL = Decibels Sensation Level, dB nHL = Decibels normal Hearing Level, PwMS = Persons with Multiple Sclerosis, IA Diff. = Inter-aural Difference, ? = not reported.

* dB SL reference to hearing thresholds (did not specify hearing thresholds to click or to pure tones)

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Section IV: Multiple Sclerosis and Vestibular Function

Table S7. Characteristics of studies examining the effects of MS on vestibular function

Test Battery	Author (Year)	Study Type	Sample Size		Mean Age PwMS (years)	PwMS Age range (Years)	% Female	MS Type (sample size)	MS Duration Mean (range) years	Results of PwMS compared to controls / normative data
			PwMS	Controls						
cVEMP	Sartucci & Logi (2002) ^[21]	Case-Control	15	15	44.5	26-59	66.6	?	?	Significantly different
	Versino et al. (2002) ^[23]	Cohort	70	18	35.5	19-61	?	?	?	31.4% Abnormal
	Alpini et al. (2004) ^[31]	Case-control	40	25	38	17-71	57.5	?	?	70% Abnormal
	Aidar and Suzuki (2005) ^[4]	Case-control	15	15	39.3	?	?	?	?	Significantly different
	Patkó et al. (2007) ^[5]	Case-control	30	30	43.4	27-60	66.6	?	?	Significantly different
	Eleftheriadou et al. (2009) ^[25]	Cohort	46	40	40	20-66	45.6	RRMS	4.6 (?)	Significantly different
	Gabelić et al. (2013) ^[12]	Case control	30	15	?	?	46.6	RRMS	3.93 (0.2-21)	Significantly different
	Harirchian et al. (2013) ^[13]	Case-control	20	20	30	20-40	50	RRMS SPMS	?	70% Abnormal
	Parsa et al. (2015) ^[29]	Cross-sectional	34	15	29.8	?	100	?	?	Significantly different
	Kavasoğlu et al. (2018) ^[17]	Case-control	30	31	30	18-45	60.0	?	< 1 (?)	23.3% Abnormal No significant difference
	Koura and Hussein (2018) ^[18]	Case-control	20	10	36.80	?	65.0	?	4.4 (?)	100% Abnormal
	Delphi et al. (2021) ^[33]	Cross-sectional	25	25	31.43	18-45	72.0	?	?	Significantly different
	Elmoazen et al. (2021) ^[22]	Case-control	20	10	Brainstem lesions: 40 No Brainstem lesion: 34.1	?	?	?	?	Significantly different
Cochrane et al. (2021) ^[34,35]	Cross-sectional	40	20	42.4	21-55	88.0	RRMS	9.9	No significant difference	
oVEMP	Gabelić et al. (2013) ^[12]	Case control	30	15	?	?	46.6	RRMS	3.93 (0.2-21)	Significantly different
	Parsa et al. (2015) ^[29]	Cross-sectional	34	15	29.8	?	100	?	?	Significantly different
	Elmoazen et al. (2021) ^[22]	Case-control	20	10	Brainstem lesions: 40 No Brainstem lesion: 34.1	?	?	?	?	Significantly different
	Cochrane et al. (2021) ^[34,35]	Cross-sectional	40	20	42.4	21-55	88.0	RRMS	9.9	No significant difference
ENG	Zeigelboim et al. (2008) ^[6]	Case-control	30	0	42.23	27-64	80	RRMS	?	86.7% Abnormal
	Degirmenci et al. (2010) ^[26]	Cohort	30	30	37.9	23-56	56.7	RRMS	?	90% Abnormal

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Table S7 continued: Characteristics of studies examining the effects of MS on vestibular function

Test Battery	Author (Year)	Study Type	Sample Size		Mean Age PwMS (years)	PwMS Age range (Years)	% Female	MS Type (sample size)	MS Duration Mean (range) years	Results of PwMS compared to controls / normative data
			PwMS	Controls						
Dynamic Posturography	Doty et al. (2018) ^[16]	Case-control	58	72	Males:44.61 Females: 44.60	?	68.9	?	Male: 7.03 (?) Female: 6.54 (?)	Significantly different
Static Posturography	Inojosa et al. (2020) ^[31,32]	Cross-sectional	99	30	35.01	18-50	68.7	?	5.5 (?)	Significantly different
	Yang and Liu (2020) ^[30]	Cross-sectional	30	25	50.8	?	76.7	?	14 (?)	Significantly different
Rotary Chair	Cochrane et al. (2021) ^[34,35]	Cross-sectional	40	20	42.4	21-55	88.0	RRMS	9.9	Significantly different

Abbreviations: cVEMP = Cervical Vestibular Evoked Myogenic Potentials, oVEMP = Ocular Vestibular Evoked Myogenic Potentials, MS= Multiple Sclerosis, PwMS = Persons with Multiple Sclerosis, ? = not reported. Cells shaded in grey represent test results that were abnormal or showed a difference between PwMS and Controls.

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Extracted Vestibular Evoked Myogenic Potentials Results

Table S8: Ocular Vestibular Evoked Myogenic Potentials Parameters and Results

Author (Year)	Stimulus (polarity) - Transducer	PR (Hz)	PL	Ave.	BP Filter (Hz)	Group	Side	Peak Latency (ms)				Amplitude (µV)	
								n1		p1		n1-p1	
								\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
Gabelić et al. (2013) ^[12]	Click (?) - Headphone	1	130 dB SPL	100	5-1000	PwMS	Average Across sides	10.30	?	14.90	?	13.10	?
						Controls		9.5	?	14	?	13.3	?
Parsa et al. (2015) ^[29]	500 Hz Tone Burst (?) - Insert earphones	?	95 db nHL	?	?	PwMS with infratentorial plaque	Right	15.67	1.32	20.59	1.65	6.61	0.88
						PwMS without infratentorial plaque		12.21	1.00	16.90	1.32	6.61	0.60
						Controls	10.2	0.48	15.1	0.87	12.77	4.12	
						PwMS with infratentorial plaque	Left	15.74	1.66	21.40	2.88	6.48	0.68
						PwMS without infratentorial plaque		11.78	0.89	16.92	0.82	6.82	0.75
						Controls		10.3	0.51	14.9	0.84	12.6	4.04
Elmoazen et al. (2021) ^[22]	500 Hz Tone Burst (condensation) -Supra aural headphones	5	95 dB nHL	150	1-1000	PwMS with Brainstem lesions	Average Across sides	11.43	1.42	16.86	1.79	3.59	3.82
						PwMS without Brainstem lesions		10.58	2.50	15.81	1.42	3.22	2.00
						Controls		10.09	0.92	14.71	1.20	2.76	1.28
Cochrane et al. (2021) ^[34]	Unspecified Tone Burst (?) - earphone unspecified	?	?	100	?	PwMS	?	8.50	1.70	12.90	2.20	5.20	3.50
						Controls		8.40	1.50	12.30	2.10	4.70	2.50

Abbreviations:

PR = Presentation Rate, PL = Presentation Level, Ave. = Number of Averages, BP = Band Pass, \bar{x} = Mean, SD = Standard Deviation, dB SPL = Decibels Sound Pressure Level, dB nHL = Decibels normal Hearing Level, PwMS = Persons with Multiple Sclerosis, ? = not reported.

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Table S9: Cervical Vestibular Evoked Myogenic Potentials Parameters and Results

Author (Year)	Stimulus (polarity) - Transducer	PR (Hz)	PL	Ave.	BP Filter (Hz)	Group	Side	Peak Latency (ms)				Amplitude (μ V)								
								p13		n23		p13-n23								
								\bar{x}	SD	\bar{x}	SD	\bar{x}	SD							
Sartucci and Logi (2002) ^[2]	Click (Rarefaction) - Headphone	3	140 dB SPL	256	10-1500	PwMS	Right	15.30	3.10	22.50	2.30	63.00	65.50							
								12.5	0.8	21.3	1.5	186.4	82.8							
							Left	14.00	2.30	20.80	2.30	73.10	58.80							
								12.3	0.9	20.8	1.3	141.1	85.8							
Alpini et al. (2004) ^[3]	Click (Rarefaction) - Headphone	5	95 dB nHL + 70 dB SPL contralateral Masking	400	?	PwMS	Right	14.40	?	22.40	?	?	?							
							Left	14.90	?	22.50	?	?	?							
							Right	13.40	2.87	18.64	2.67	12.17	6.50							
								11.12	1.64	15.15	2.51	7.54	5.95							
Aidar and Suzuki (2005) ^[4]	Click (Rarefaction) - Headphone	2	95 dB HL	200	20-1000	PwMS	Right	13.49	1.77	17.84	1.27	13.30	3.63							
								10.76	1.59	14.86	2.85	7.23	4.76							
							Left	14.40	1.50	21.30	3.20	11.61	3.63							
								12.7	1.5	21.3	3.7	16.02	5.34							
Patkó et al. (2007) ^[5]	Click (Rarefaction) - Headphone	5	133 dB SPL	250	10-1600	PwMS	Right	14.8	1.5	21.2	3.2	11.07	2.87							
								12.9	1.9	20.7	2.8	13.85	4.3							
							Left	PwMS with brainstem lesions	15.48	1.40	23.94	1.51	?	?						
								PwMS without brainstem lesions	14.56	1.20	23.25	1.42	?	?						
Eleftheriadou et al. (2009) ^[25]	Click (Rarefaction) - Headphone	5	105 dB HL	250	5-1500	Controls	Average across sides	12.67	1.1	21.66	1.11	?	?							
								Gabelić et al. (2013) ^[12]	Click (?) - Headphone	1	130 dB SPL	100	5-1000	PwMS	15.80	?	24.90	?	1.90	?
															Controls	14.6	?	22.1	?	1.6
Harirchian et al. (2013) ^[13]	Click (Rarefaction) - Headphone	2	95 dB nHL + 40 dB nHL contralateral Masking	200	10-1000	PwMS	Right	22.20	9.30	30.02	11.20	?	?							
								12.9	1.4	21.3	1.6	?	?							
							Left	PwMS	20.20	7.05	30.71	16.20	?	?						
								Controls	13.1	1.9	20.6	1.9	?	?						
							IA Diff.	PwMS	2.05	8.80	0.70	10.90	?	?						
								Controls	0.17	2.2	0.4	2.5	?	?						

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Table S9 Continued: Cervical Vestibular Evoked Myogenic Potentials Parameters and Results

Author (Year)	Stimulus (polarity) - Trasducer	PR (Hz)	PL	Ave.	BP Filter (Hz)	Group	Side	Peak Latency (ms)				Amplitude (μ V)		
								p13		n23		p13-n23		
								\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	
Parsa et al. (2015) ^[29]	500 Hz Tone Burst (?) -Insert earphones	?	95 db nHL	?	?		Right	PwMS with infratentorial plaque	18.75	1.81	28.15	1.43	118.82	29.97
								PwMS without infratentorial plaque	17.44	1.03	26.89	1.87	135.00	20.31
								Controls	15.25	0.9	24.55	1.07	180	44.97
								PwMS with infratentorial plaque	19.11	1.72	28.88	2.27	119.65	26.02
								PwMS without infratentorial plaque	17.21	1.05	26.87	1.36	133.78	22.89
								Controls	15.31	0.93	24.48	1.18	175	57.59
Kavasoğlu et al. (2017) ^[17]	Click (Rarefaction) - Headphone	5	100 dB nHL	100	10- 1000		Right	PwMS	12.90	2.10	21.20	1.78	7.10	2.80
								Controls	12	0.9	20.6	1.95	7.7	3.1
								PwMS	12.90	2.20	21.40	2.10	7.00	2.50
								Controls	12.03	0.96	20.76	1.63	7.6	3
Koura and Hussein (2018) ^[18]	500 Hz Tone Burst (Rarefaction) -TDH 39 Headphones	5.1	95 db HL	200	?		Right	PwMS	17.14	0.71	26.82	0.84	41.88	1.71
								Controls	13.83	1.14 5	20.76	3.43	61.18	34.64
								PwMS	17.20	0.56	27.17	0.75	54.95	28.27
								Controls	14.43	0.70 2	22.3	1.725	65.74	18.51
Delphi et al. (2021) ^[33]	500 Hz Tone Burst (?) -?	5.1	95 dB nHL	?	10- 1200		Right	PwMS	18.20	1.93	27.37	2.45	121.34	29.05
								Controls	14.96	1.02	24.21	2.10	169.21	48.76
								PwMS	18.95	2.01	27.21	2.80	-	-
								Controls	15.02	1.10	24.12	2.30	-	-
Elmoazen et al. (2021) ^[22]	500 Hz Tone Burst (condensation) -Supra aural headphones	5	95 dB nHL	150	1- 1000		Average across sides	PwMS with Brainstem lesions	16.49	1.49	25.96	1.93	66.25	52.42
								PwMS without Brainstem lesions	15.21	1.57	23.97	2.06	93.12	78.01
								Controls	14.05	0.94	23.36	2.14	144.42	122.73
Cochrane et al. (2021) ^[34]	Unspecified Tone Burst (?) – earphone unspecified	?	?	?	?		?	PwMS	13.70	1.30	21.10	2.60	12.70	7.60
								Controls	13.30	0.50	20.60	1.80	16.50	7.10

Abbreviations:

PR = Presentation Rate, PL = Presentation Level, Ave. = Number of Averages, BP = Band Pass, \bar{x} = Mean, SD = Standard Deviation, dB SPL = Decibels Sound Pressure Level, dB HL = Decibels Hearing Level, dB nHL = Decibels normal Hearing Level, PwMS = Persons with Multiple Sclerosis, IA Diff. = Inter-aural Difference, ? = not reported. Cells Highlighted in Yellow indicate that "normalized amplitudes" were reported as opposed to absolute amplitudes reported by other studies. Cells Highlighted in Green indicate results were reported without specifying side or if they are averaged across sides.

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