

# Medical evaluation as gold standard to control iPrognosis application derived data for early Parkinson's disease detection



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Background

Smartphones as daily companions are the digital health tools of the future due to the potential of longitudinal, unobtrusive, remote real-life monitoring of people's behavior. In the i-PROGNOSIS project, we developed the "iPrognosis" Android smartphone application for unobtrusive remote data collection in the general population, with the aim of evolving it into an early Parkinson`s disease (PD) detection tool. Early detection of behavioral changes being linked to motor and non-motor symptoms (NMS) of PD allows for timely clinical diagnosis which is an unmet need.

Table 1: iPrognosis App-usage and baseline characteristics of GData-participants									
	Germany	Greece	Portugal	UK	Spain	Austria	Australia	Chile	Overall
No. of users who provided consent	760	727	473	288	41	59	8	31	2387
No. of participants who contributed data	531	545	342	232	30	36	6	12	1703
Demographic characteristics of participants (self-reported)									
No. of PD patients / Healthy controls	89/596	60/599	21/391	136/117	6/32	10/45	2/3	1/26	325/1809
Avg. participant age, years (std)	52 (14)	42 (16)	45 (15)	58 (13)	50 (15)	52 (14)	42 (17)	43 (15)	48 (16)
No. of women / men	252/433	219/440	168/245	118/135	11/27	20/35	1/0	10/17	799/1336

Objective

A medical evaluation protocol as gold standard for controlling iPrognosis application derived data of an international multilingual study.

Methods

**iPrognosis Android Smarthone App:** unobtrusive and passive assessment of participants` behavioral data from the daily use of their smartphones (= GData) in eight countries since 5/2017

**GData = App:** defined based on motor & non-motor symptoms of Parkinson`s disease:

- speech → *Dysarthrophonia*
- movement (holding the smartphone, typing a message) → *Tremor, Brady-/Hypokinesia, Rigidity*
- facial expression → *Hypomimia*
- mood → *Depression*

**„Gold-Standard“ = Physician:** baseline and six month follow-up assessment of participants based on a standardised medical evaluation protocol by a movement disorders specialist in three center:

- physician and participant-based scales covering motor, NMS & health related quality of life
- instrumental diagnostics (olfactory test, actigraphy for tremor, SN sonography)

Table 3: Parkinson specific characteristics		
	Baseline	6 month follow-up
PD duration in years: mean (std)	4.94 (3.48),	6.22 (3.85),
min.-max. in years	0.38 - 14.61	1.07 – 15.26
Dominant motor condition, OFF/ON/Dyskinesia (N)	3/59/2	2/17/1
Duration of PD medication intake: mean (std), min.-max. in years	4.70 (3.46),	6.22 (3.85),
	0.12 – 14.61	1.07 – 15.06
Drug naïve for PD medication yes/no (N)	8/58	2/21
Advanced therapies (pump, DBS) yes/no (N)	0/66	0/23

Conclusion

Smartphones have the ability of longitudinal, unobtrusive, remote real-life recognition and monitoring of people's behavior and of specific behavioral pattern. The i-PROGNOSIS approach is promoting as both, the iPrognosis App derived behavioral pattern and the medical evaluation of Parkinson`s disease symptoms by a movement disorders specialist as gold standard differentiate patients with Parkinson`s disease and healthy controls.

Table 2: „Gold-standard“ controlled GData - participants						
	Baseline			6 month follow-up		
	Parkinson patients	Healthy controls	p-value	Parkinson patients	Healthy controls	p-value
N	66	43		23	11	
No. of women / men	22/44	25/18	0.01	7/14	7/3	0.06
Mean Age, years (std)	60.53 (8.41)	55.02 (11.46)	0.01	62.22 (8.80)	52.05 (10.92)	0.01

Table 4: Motor and non-motor scores						
	Baseline			6 month follow-up		
Mean value (std), min.-max.	Parkinson patients	Healthy controls	p-value	Parkinson patients	Healthy controls	p-value
UPDRS Pat III	18.77 (9.82), 3-62	1.81 (4.21), 0-22	0.001	14.43 (8.74), 2-32	0.18 (0.60), 0-2	0.001
Hoehn & Yahr						
in ON motor state	1.86 (0.61), 1-3	0.09 (0.37) 0-2	0.001	1.91 (0.68), 1-3	0.00 (0.00), 0-0	0.001
in OFF motor state	2.93 (0.94), 1-5			2.73 (1.24), 1-5		
NMSS	31.88 (29.15) 0-139	10.93 (17.37) 0-88	0.001	32.27 (23.10), 2-82	8.11 (12.33) 0-32	0.001
NMSQuest	6.34 (4.62) 0-23	2.58 (2.88) 0-10	0.001	4.19 (2.56) 0-9	3.60 (3.84) 0-12	0.6
PDQ-8	5.68 (4.35) 0-20	1.32 (2.34) 0-11	0.001	5.00 (4.55) 0-13	2.56 (3.94) 0-11	0.2
UPDRS part II	7.52 (5.49) 0-27	0.90 (1.99) 0-10	0.001	7.05 (5.50) 0-17	0.20 (0.63) 0-2	0.001

Table 5: Comparison of „gold-standard“ and App-based indicators								
	Tremor at rest		Action / postural tremor		Rigidity		Brady-/Hypo-kinesia	
	Gold-Standard	GData	Gold-Standard	GData	Gold-Standard	GData	Gold-Standard	GData
	N=26 PD N=16 HC	N=109 PD N=375 HC	N=26 PD N=16 HC	N=109 PD N=375 HC	N=17 PD N=4 HC		N=17 PD N=4 HC	
Sensitivity	0.64	0.49	0.45	0.49	1.00	0.74	1.00	0.67
Specifity	0.67	0.77	0.58	0.77	0.71	0.74	0.88	0.79
Diagnostic accuracy	0.66	0.71	0.54	0.71	0.76	0.74	0.90	0.70

