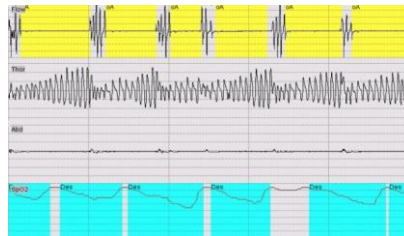


# SCREENING FOR OSAS IN PHILIPS EMPLOYEES



Michiel Eijsvogel Medisch Spectrum Twente



# Why think about screening for OSAS?

- prevalent disease
- disease interfering with:  
well-being, social activity and work
- cardiovascular & accident risk
- effective therapy is available



# Screening considerations

- Hospital / Sleep Clinic
  - Patients → (GP) → sleepclinic
  - High prevalence
  - Skilled professionals & equipment
  
- Screening
  - Clients
  - Low prevalence
  - Simple diagnostics
  
- Problems!
  - OSAS definition?
  - Gold standard PSG?
  - Scientific evidence to screen?



# Statistics

	Gold +	Gold -	
Test +	TP	FP	TP+FP
Test -	FN	TN	TN+FN
	TP+FN		

Sensitivity

TP / TP+FN

TN / TN +FP

TP / TP+FP

TN / FN+TN

TP+FN / Total

TEST IN H  
PREVALEN

So in primary care and screening reducing false positive rate by means of a high specificity test is always needed

PRIMARY CARE  
10%

	AHI ≥	<5	
Pos Q	80	1800	2600
Neg Q	20	200	7400
	100	9000	10000

Sensitivity can be balanced against the importance of missing a true case

In both tests Sens=Spec=80%

FP 20 → 1800 (90x) → 2600 PSG for finding 800 OSAS patients



# Screening Questionnaires OSAS

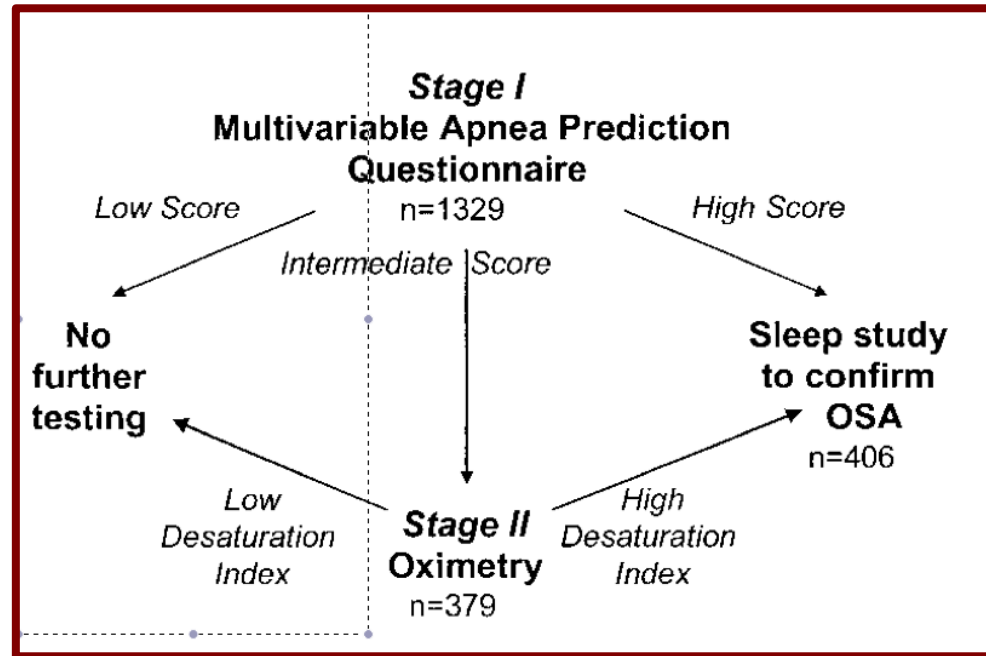
## Systematic review 2010 Abrishami

- 1484 studies → 10 studies; 6 real screening!
- Possible verification bias 8 /10
- Pooled Sensitivity 77% Specificity 53%
- High quality: questions with: snoring, tiredness, observed apnea, high RR, age, NC, gender
- Ideal screening Q :
  1. Feasibility (simple Q)
  2. Accuracy (clear validation)
  3. Generalizability (different popul.)
- 2 step strategy is promising



# 2 step strategy

Gurubhagavatula 2004 Commercial drivers



**Results ↑ with 3 groups and 2 step strategy**  
**Results ↑ with  $AHI \geq 30$  as “OSA”**

Am J Respir Crit Care Med 2004 Aug 15;170(4):371-6.

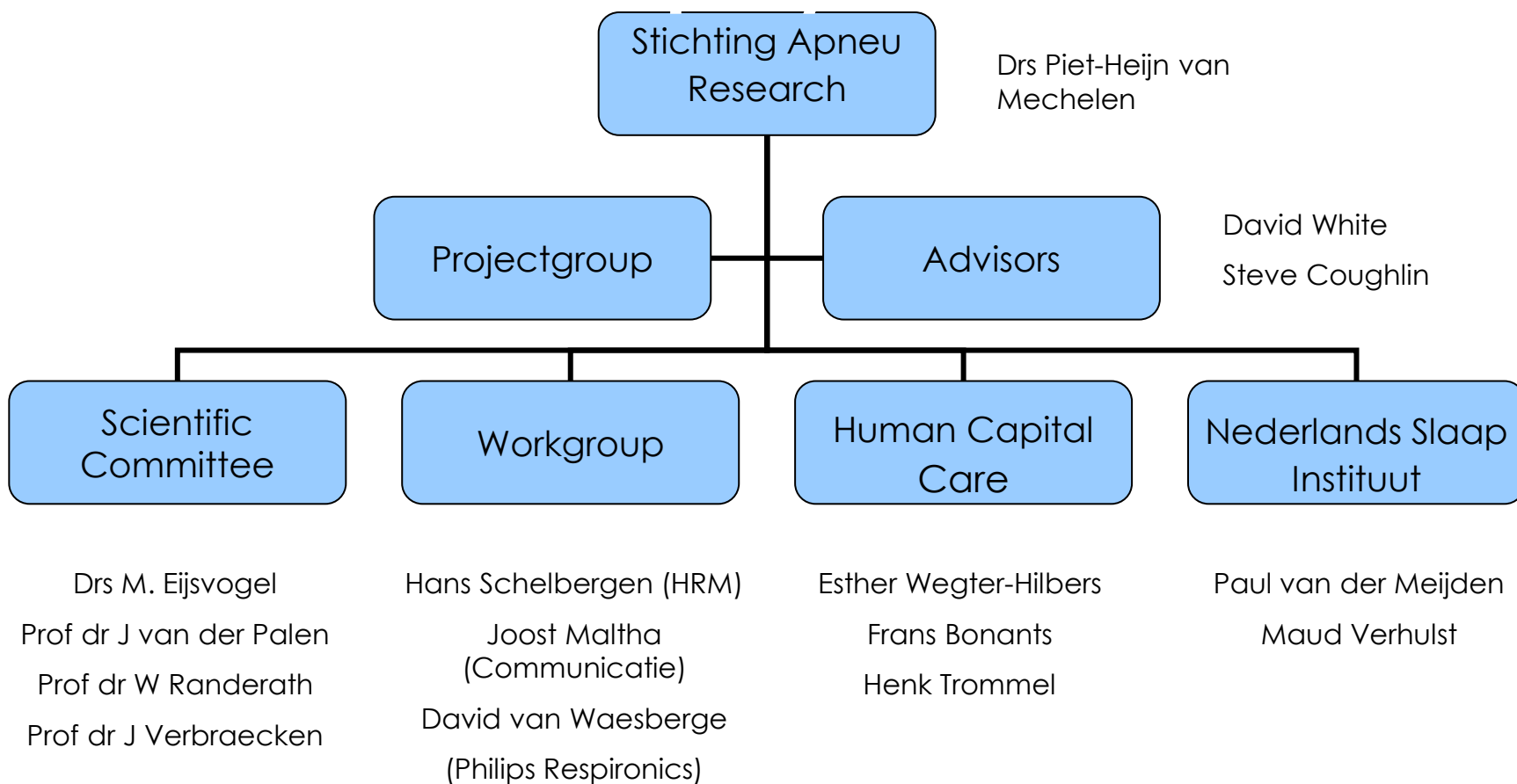


# Philips employees OSAS studies

- Develop and validate a screening test
  - Sample study
  
- Offer this test to all Dutch Philips employees
  - Screening study



# Organization





# Sample Study . Tests in all

**Berlin Questionnaire**  
Sleep Evaluation in Primary Care

Please Complete the following

height \_\_\_\_\_  
weight \_\_\_\_\_

Category 1

1. Do you snore?  
 yes  
 no  
 don't know

If you snore:  
 2. Your snoring is?  
 slightly louder than breathing  
 as loud as talking  
 louder than talking  
 very loud. Can be heard in another room

3. How often do you snore?  
 nearly every day  
 3-4 times a week  
 1-2 times a week  
 1-2 times a month  
 never or nearly never

4. Has your snoring ever bothered other people?  
 yes  
 no

5. Has anyone noticed that you quit breathing during your sleep?  
 nearly every day  
 3-4 times a week  
 1-2 times a week  
 1-2 times a month  
 never or nearly never

6. BMI > 30 (See Chart)  
 yes  
 no

Name \_\_\_\_\_  
Address \_\_\_\_\_

<b>STOP</b>	<b>S: SNORING</b>	Y/N
	<b>T: TIREDNESS</b>	Y/N
	<b>O: OBSERVED APNEAS</b>	Y/N
	<b>P: BLOOD PRESSURE</b>	Y/N
	<b>R: RESPIRATORY</b>	Y/N
<b>STOP-BANG</b>		Y/N
		Y/N
		Y/N
		Y/N
		Y/N

**Athens Insomnia Scale (AIS)**  
**Epworth Sleepiness Scale (ESS)**  
**Pittsburg Sleep Quality Index (PSQI)**  
**Additional Question list**

(4):339-45



# OSAS definition

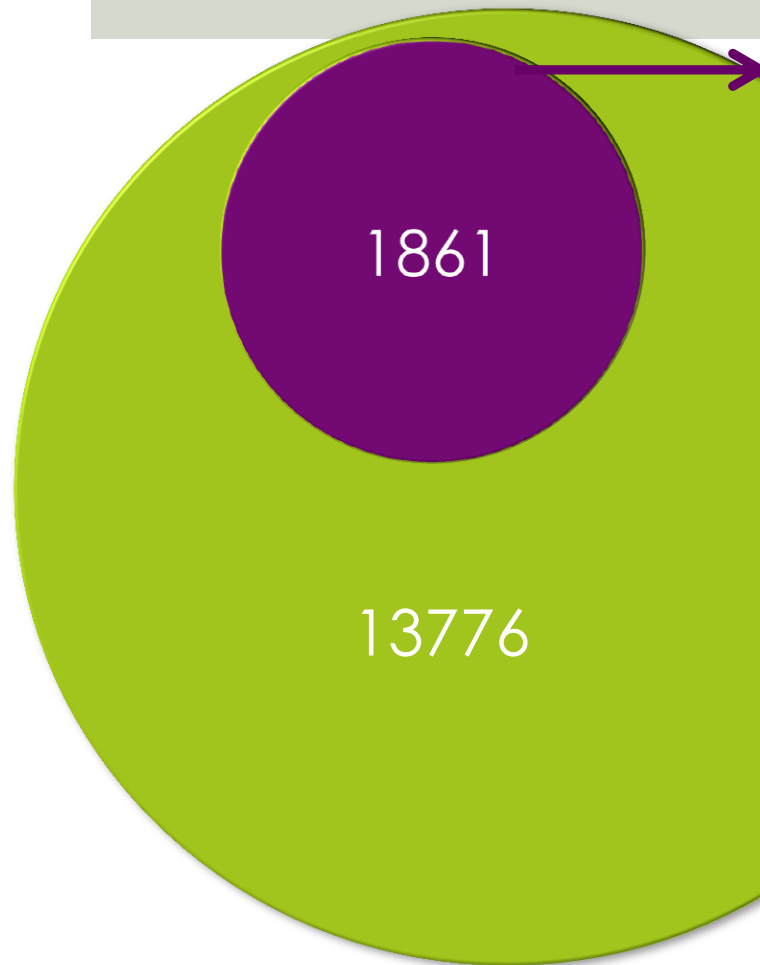
OSAS = AHI  $\geq$  15 together with  
 AHI 5-15 + questionnaire derived symptoms  
 but without overt insomnia

## Symptoms table

AHI 5-15	Evaluation of symptoms (Chicago criteria)	Source	Module code
	<b>EXCESSIVE DAYTIME SLEEPINESS</b>		
		or ESS $\geq$ 10	3.1 $\rightarrow$ 3.8
		or Berlin Q8 (Nodding off or falling asleep while driving; nearly every day/3-4 times a week)	1.8
		or AIS Q8 (Daytime sleepiness: mild/considerable/intense)	4.8
<b>OR</b>	<b><math>\geq</math> 2 OF THE FOLLOWING:</b>		
	<i>Choking or gasping during sleep</i>	or NA	NA
	<i>Recurrent awakenings from sleep</i>	or AIS Q2 (Awakenings during the night: minor problem/considerable problem/ serious problem/ or did not sleep at all)	4.2
	<i>Unrefreshed sleep</i>	or Berlin Q6 (How often do you feel tired or fatigued after your sleep: nearly every day/ 3-4 times a week)	1.6
	<i>Daytime fatigue</i>	or STOP Q2 (yes)	2.2
		or Berlin Q7 (During your waketime, do you feel tired, fatigued or not up to par: nearly every day/ 3-4 times a week)	1.7
	<i>Impaired concentration</i>	or NA	NA
<b>AND</b>	<b>ABSENCE OF INSOMNIA</b>	Athens insomnia Scale Total score $\leq$ 10	4

NA= not available





<b>Invitation letter to employees</b>		<b>1861</b>
<b>Returned consent forms</b>		<b>249</b>
<b>Returned questionnaires</b>		<b>235</b>
<b>Participation sleep studies</b>		<b>190</b>
no participation due to OSAS diagnosis	8	
no participation due to other reasons	37	
<b>Complete PSG+PG</b>		<b>176</b>
incomplete data PSG	4	
incomplete data RU-sleeping	10	
		<b>(9,5%)</b>



# Statistical process

1. Looking to individual Questionnaires
2. Is different scoring of the Questionnaires better?  
(Low-High  $\leftrightarrow$  Low-Intermediate-High)
3. Do individual variables predict OSAS?
4. Do logistic regression in multivariate model with predictive variables and with different cut-off points of questionnaire
5. Best questions with optimal cut-off points (low-intermediate-high risk) is new screening strategy



<b>Gender M/ F</b>	<b>73% / 27%</b>
<b>Age mean (range)</b>	<b>47 ± 9,2</b>
<b>BMI mean</b>	<b>26,9 ± 4,3</b>
<b>BMI ≥ 30</b>	<b>14%</b>
<b>Neck cir. &gt; 40 cm</b>	<b>27%</b>
<b>male</b>	<b>39,6 ± 2,1</b>
<b>female</b>	<b>35,0 ± 2,4</b>
<b>Hypertension "yes"</b>	<b>19%</b>

<b>already treated for OSAS?</b>	<b>3 %</b>
<b>have a sleep study before?</b>	<b>5 %</b>
<b><u>not</u> have a regular bed partner?</b>	<b>12 %</b>
<b>answered the questions together?</b>	<b>40 %</b>
<b>drink (almost) daily alcohol?</b>	<b>20 %</b>
<b>(almost) daily a stuffed nose?</b>	<b>23 %</b>
<b>treated for cardiac arrhythmia?</b>	<b>4 %</b>
<b>have ever a CVA or TIA?</b>	<b>1 %</b>

<b>Questionnaires</b>	<b>Pos</b>	<b>Score</b>
<b>Berlin Q</b>	<b>36%</b>	<b>≥ 2 C</b>
<b>STOP</b>	<b>45%</b>	<b>≥ 2</b>
<b>STOP-BANG</b>	<b>57%</b>	<b>≥ 3</b>
<b>ESS</b>	<b>9%</b>	<b>≥10</b>
<b>PSQI</b>	<b>34%</b>	<b>&gt; 5</b>
<b>AIS</b>	<b>7%</b>	<b>&gt;10</b>
<b>RU-Flow</b>	<b>35%</b>	<b>&gt;15</b>
<b>PSG AHI</b>	<b>49%</b>	<b>≥ 5</b>
	<b>18%</b>	<b>≥15</b>
	<b>6%</b>	<b>≥30</b>
<b>OSAS</b>	<b>37%</b>	<b>≥ 5+S</b>



# STOP-BANG QUESTIONNAIRE

<b>STOP-BANG</b>	<b>STOP</b>	<b>S: SNORING</b>	Y/N
		<b>T: TIREDNESS</b>	Y/N
		<b>O: OBSERVED APNEAS</b>	Y/N
		<b>P: BLOOD PRESSURE</b>	Y/N
	<b>BANG</b>	<b>B: BMI <math>\geq 35</math> ?</b>	Y/N
		<b>A: Age <math>\geq 50</math> y ?</b>	Y/N
		<b>N: NC <math>\geq 40</math> cm ?</b>	Y/N
		<b>G: Gender male ?</b>	Y/N

## Scoring:

**STOP:** High risk of OSA: answering yes to  $\geq 2$  questions

**STOP-BANG:** High risk of OSA: answering yes to  $\geq 3$  questions



# STOP-BANG. The best Q (classic scoring)

	OSAS +	OSAS -		P value		AHI $\geq 15$	AHI $< 15$	P value
<b>High Risk</b>	<b>55</b>	51	106	$< 0.001$		<b>28</b>	78	0.001
<b>Low Risk</b>	14	<b>66</b>	80			6	<b>74</b>	
	69	117	186			41	145	

Cut-off	Sens	Spec	PPV	NPV	Prev
<b>OSAS</b>	<b>80%</b>	<b>56%</b>	52%	83%	<b>37%</b>
AHI 15	68%	51%	26%	93%	22%



# RU-sleeping: Nasal flow measurement

2 x2 tabel	OSAS +	OSAS -	Total		AHI $\geq 15$	AHI $< 15$	Total
RU-sleeping 15+	38	23	61		24	37	61
RU-sleeping 15-	27	88	115		7	108	115
Total	65	111	176		31	145	176

Cut-off	Sens	Spec	PPV	NPV	Prev
OSAS	58%	79%	62%	77%	37%
AHI 15	77%	74%	52%	94%	18%





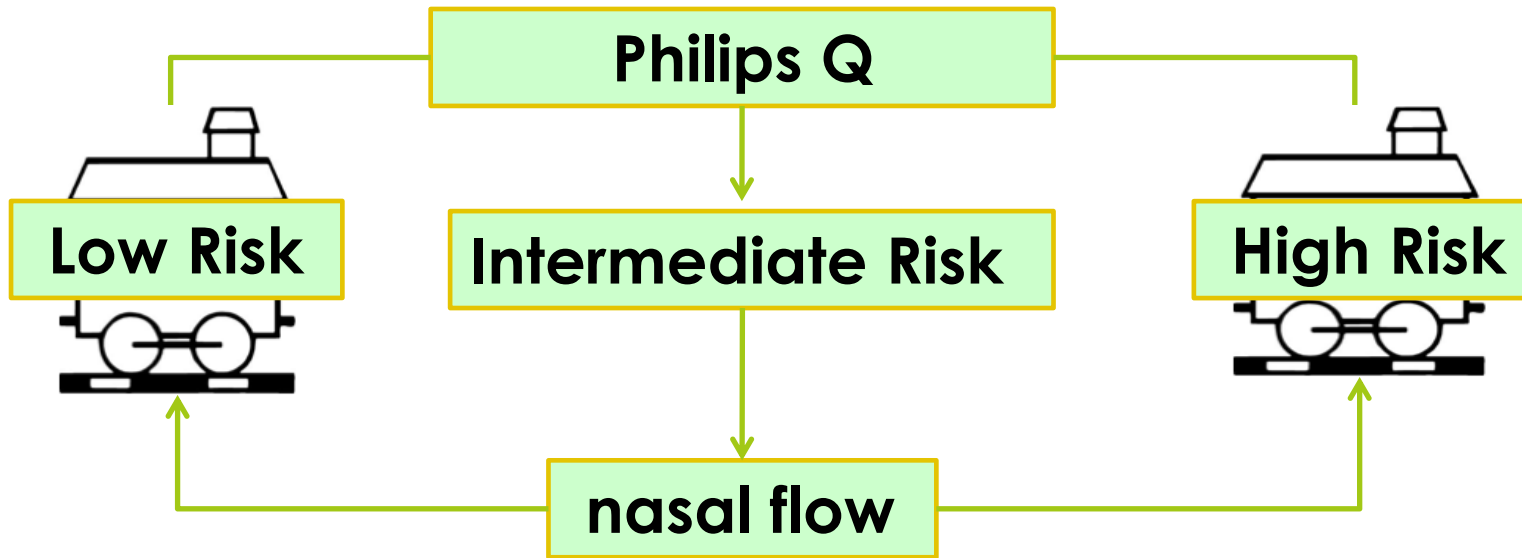
# Variables predicting OSAS

3-way instead of 2-way scoring  
STOP-BANG L= 0-1 Int= 2-4 H= >4  
Berlin Q L= 0-1 Int= 2 H= 3

	Odds Ratio	Sig.
AIS scoring <10 vs. >=10	27,039	0,013
STOPBANG High vs. Low	8,125	0,012
STOPBANG Intermediate vs. Low	2,810	0,132
Berlin Q High vs. Low	28,910	0,023
Berlin Q Intermediate vs. Low	4,402	0,065
Age >45 vs. <=45	2,904	0,011
Berlin Q-5 (Breathing stops) Yes vs. No	3,381	0,054
Heart failure /arrhythmia Yes vs. No	41,333	0,039



# PHILIPSQ 3 WAY SCORING & 2-STEP MODEL



**Philips Q = set of 28 items + formula** → computing individual change (0-100 %)  
**Changing cut-off settings low and high** → different group having OSAS J/N  
→ different sens/specif of 2 step strategy  
→ choose optimum settings (sens /spec.)



# Model in 10000p. Consequences of choices!

Prev. <u>10%</u>	Lower	Upper	Sens.	Specif.	TP	FP	TN	FN	RU	To CLINIC	for PSG
	cut-off	cut-off							RU	Nr pat	OSAS
<b>Ideal test</b>			100%	100%	1000	0	9000	0	0	1000	100%
<b>High sensitivity</b>	25	45	82%	69%	815	2835	6165	185	162	3650	22%
<b>High specificity</b>	35	55	66%	89%	661	971	8029	339	2764	1632	41%



Complete data (176/1861) 9,5%

OSA (AHI  $\geq 5$ ) 49%

OSAS (PSG+ sym.) 37%

Poor sleep quality (PSQI) 34%

Insomnia (AIS) 7%

EDS (ESS) 9%

PM- type IV (RU-nasal flow) Sens. 59 % Spec. 79 %

3-way Q-scoring + RU-flow: best results

New Philips Q + RU-flow with high specificity model best choice



# PHILIPS Sample Study Model results

## PHILIPS Vragenlijst

met betrekking tot  
Slaap Apneu



A good night's sleep  
with Philips

Deze Philips Vragenlijst is speciaal ontwikkeld om te kunnen berekenen hoe groot de kans is dat je last hebt van slaap apneu. De vragenlijst bevat 3 modules met in totaal 28 vragen over jou, je gezondheid, je slaap gedrag en je welzijn.  
Het is van belang dat je op alle vragen antwoord geeft, zelfs als de vragen erg op elkaar lijken. Al je antwoorden zijn nodig om je risico op slaap apneu te kunnen berekenen!



**Questionnaire:**

**Negative** → “no OSAS”

**Intermediate** → nasal flow

**Positive** → to Clinic

**Sensitivity 66 %**

**Specificity 89 %**

**When Prevalence 9 %**

**Pos Pred Value 41 %**

**Neg Pred Value 96 %**

1861

13776

**Berlin Questionnaire**  
Sleep Evaluation in Primary Care

Please Complete the following:

1. Do you snore?  
 Yes  
 No  
 If yes, how often?  
 1-2 times a week  
 3-4 times a week  
 5-7 times a week  
 8-14 times a week  
 15 or more times a week

2. Your partner has told you that you snore?  
 Yes  
 No  
 If yes, how often?  
 1-2 times a week  
 3-4 times a week  
 5-7 times a week  
 8-14 times a week  
 15 or more times a week

3. How often do you wake up during the night?  
 1-2 times a week  
 3-4 times a week  
 5-7 times a week  
 8-14 times a week  
 15 or more times a week

4. Has your morning ever bothered other people?  
 Yes  
 No  
 If yes, how often?  
 1-2 times a week  
 3-4 times a week  
 5-7 times a week  
 8-14 times a week  
 15 or more times a week

5. Has anyone noticed that you quit breathing during your sleep?  
 Yes  
 No  
 If yes, how often?  
 1-2 times a week  
 3-4 times a week  
 5-7 times a week  
 8-14 times a week  
 15 or more times a week

6. How often do you wake up during the night?  
 1-2 times a week  
 3-4 times a week  
 5-7 times a week  
 8-14 times a week  
 15 or more times a week

7. During your waking hours, do you feel tired?  
 Yes  
 No  
 If yes, how often does it occur?  
 1-2 times a week  
 3-4 times a week  
 5-7 times a week  
 8-14 times a week  
 15 or more times a week

8. Have you ever needed off or taken a nap during a workday?  
 Yes  
 No  
 If yes, how often does it occur?  
 1-2 times a week  
 3-4 times a week  
 5-7 times a week  
 8-14 times a week  
 15 or more times a week

9. Do you have a BMI  $\geq 35$ ?  
 Yes  
 No

10. Are you  $\geq 50$  years old?  
 Yes  
 No

Scoring: Snoring: Any answer within the last 4 is positive. Category 1 is positive with 1 or more positive responses to questions 1-4. Category 2 is positive with 2 or more positive responses to questions 1-4. Category 3 is positive with 3 positive responses to questions 1-4. Final result: 0-2 is non-suspect, category 3 is suspect. Positive always indicates sleep apnea.

STOP	S: SNORING	Y/N
	T: TIREDNESS	Y/N
	O: OBSERVED APNEAS	Y/N
BANG	P: BLOOD PRESSURE	Y/N
	B: BMI $\geq 35$ ?	Y/N
	A: Age $\geq 50$ y ?	Y/N



Athens Insomnia Scale (AIS)  
 Epworth Sleepiness Scale (ESS)  
 Pittsburg Sleep Quality Index (PSQI)  
 Additional Question list

Sensitivity	66 %
Specificity	89 %
When Prevalence	9 %
Neg Pred Value	96 %



**PHILIPS**  
Vragenlijst

met berekening tot  
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---

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Deen Philips Vragenlijst is speciaal ontwikkeld om te kunnen berekenen hoe groot de kans is dat je last hebt van slaap apneu. De vragenlijst bevat 3 modules met in totaal 28 vragen over jou, je gezondheid, je slaap gedrag en je werkdag. Het is van belang dat je op alle vragen antwoord geeft, zelfs als die vragen erop afkijken lijken. Al je antwoorden zijn nodig om je risico op slaap apneu te kunnen berekenen!



4.026  
(29%)

Invitation letter to employees		13.776
Returned PhilipsQ	29%	4.026
Green (Low Risk OSAS)	67 %	2.707
Orange (Intermediate Risk)	22 %	877
Red (High Risk OSAS)	11 %	442

OSAS-Home PSG		217
Known OSAS		81
<u>Total OSAS</u>		298

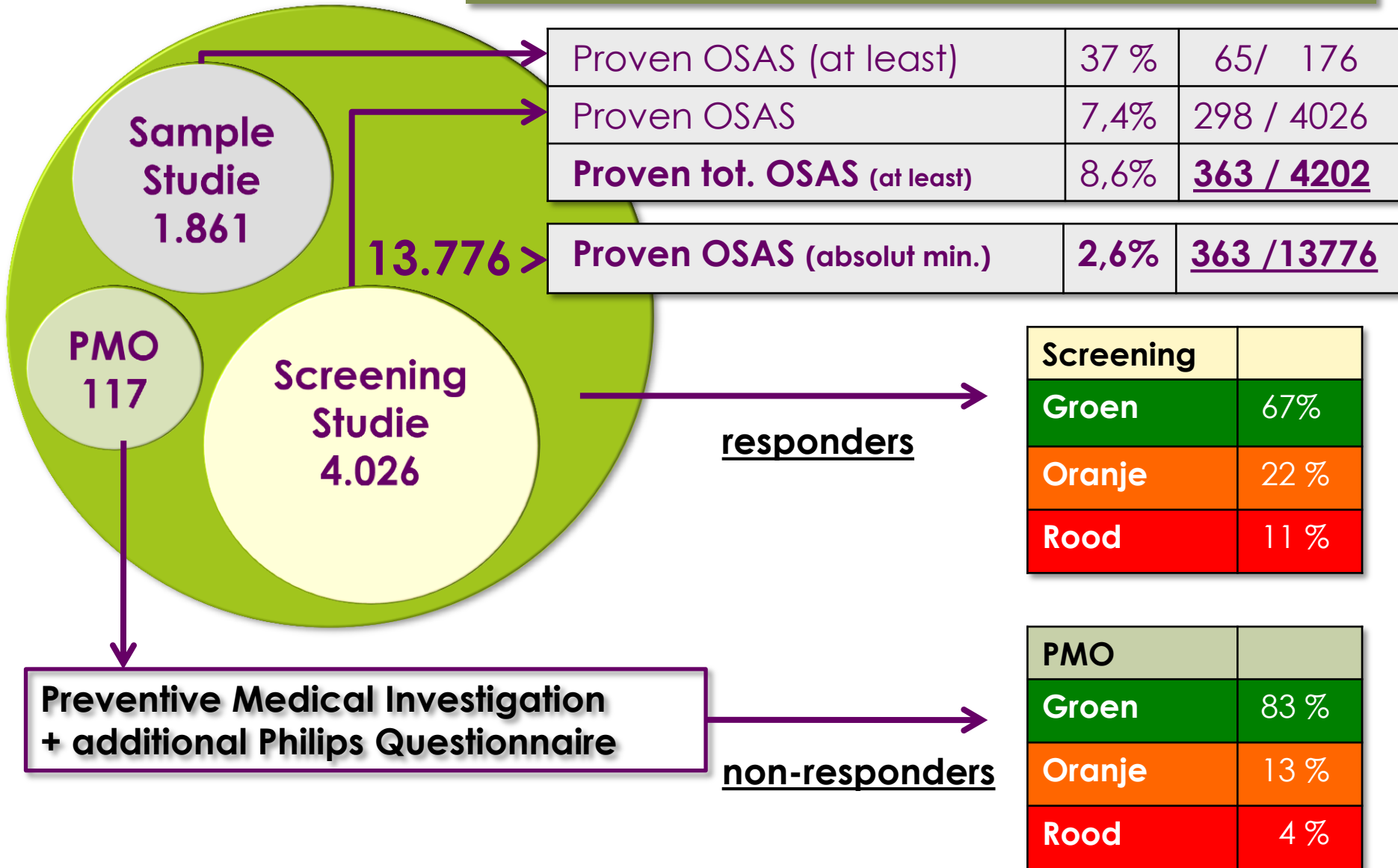
Orange		877
Asked for Nasal Flow		855
Respos Nasal Flow	60 %	523
Green (Low Risk OSAS)	58 %	301
Red (High Risk OSAS)	42 %	222

Red		664
Invited for H-PSG		664
Performed H-PSG	46 %	306
No OSAS	29 %	89
OSAS	71 %	217

Final code PhilipsQ		4.026
Green	75 %	3008
Missing Orange data	9 %	354
Red	16 %	664



# Estimation prevalence OSAS Dutch Philips work force





# Estimation prevalence OSAS Dutch Philips working force

1 = missing data = 0 OSAS!    2 = computed with no missing data

	Participated Nr: 4.026		Not Participated Nr: 9.750		Total Philips Nr: 13.776	
	1	2	1	2	1	2
<b>Nasal flow respons</b>	60%	100%	60%	100%	60%	100%
<b>Red %</b>	16,5 %	20,2 %	7,7 %	9,4 %		
<b>Red Nr</b>	664	814	751	916		
<b>% perf. PSG</b>	46%	100%	46%	100%	46%	100%
<b>% PSG pos</b>	71%	71%	71%	71%		
<b>OSAS (+ 81 known OSAS* )</b>	298*	578	245	651	543	1229
<b>% OSAS</b>	7,4 %	14,3%			<b>3,9%</b>	<b>8,9%</b>



# Final Conclusions

- Sample study in 1.861 employees
  - 9,5 % participation (5 Q + PG +PSG)
  - strong self-selection, therefore solid 4x4 table
  - outcome: 1 Philips Q + partial population PG
    - Sensitivity 66%, Specificity 89%
    - Prevalence 9% → Neg Pred Value 96%
  
- Screening study in 13.766 employees
  - 29% participation
    - No second control study with PSG in this group
  - self-selection
  - small sample in non-participation group
  - Estimation of prevalence OSAS in Dutch Philips employees
    - 2,2 %  $\leftrightarrow$  14,3 % (absolute borders)
    - 3.9 %  $\leftrightarrow$  8,9 % (mean 6,4%)



?

