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Heat Surveys in Hot Places:
Predictors of Heat Illness Events in Phoenix, Arizona

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BACKGROUND & OBJECTIVES

Past heat vulnerability research

- Which variables do we know matter? Drawing from the heat vulnerability index (Harlan et al. 2013; Reid et al. 2009)

Socioeconomic status | Age | Central air conditioning
Social isolation | Health status | Vegetation density

- Household surveys may allow us to gain greater insight into the drivers of heat-related health events, particularly those that don't result in formal medical care

Residential Social Surveys in Phoenix, AZ

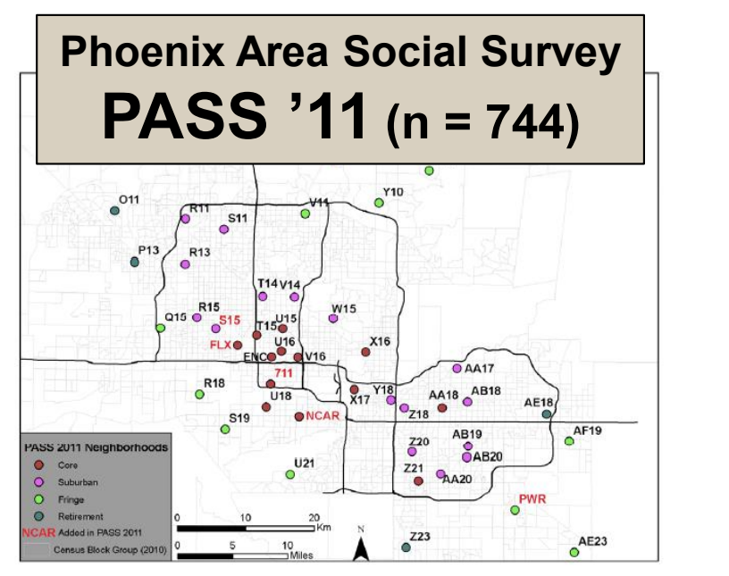
Specifically ask residents about

- experience with heat illness
- perceptions of heat in their home and neighborhood
- access to household cooling resources
- limitations on use of household cooling resources

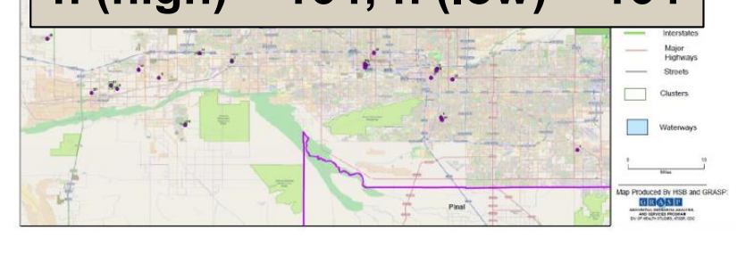
Surveys were administered in:

- different neighborhoods
- different years
- using different sampling strategies

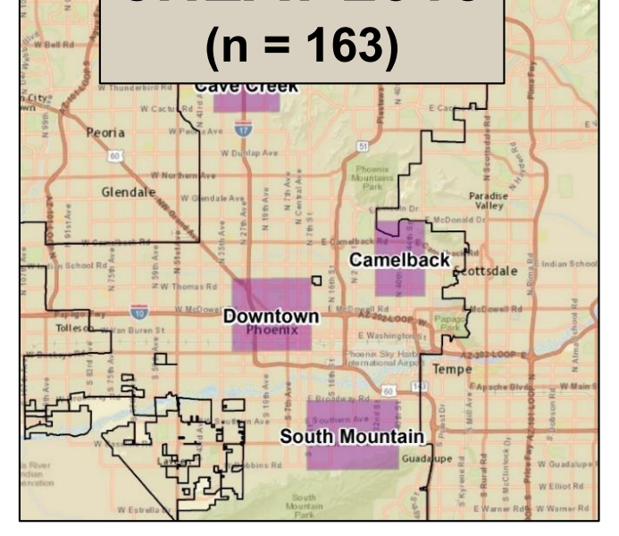
Phoenix Area Social Survey
PASS '11 (n = 744)



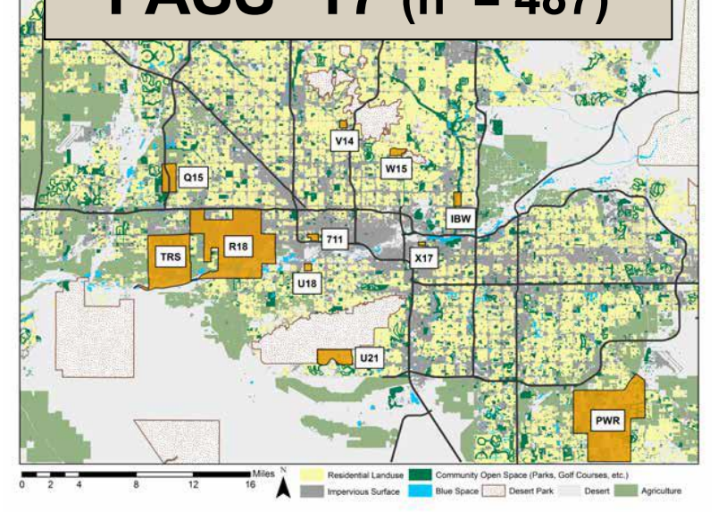
Community Assessment for Public Health Emergency Response (Maricopa County)
CASPER 2015
n (high) = 164; n (low) = 164



3HEAT 2016
(n = 163)



Phoenix Area Social Survey
PASS '17 (n = 487)



Research Objectives

R1) Identify how individual survey variables that are the same/similar across surveys affect incidence of household heat-related illness in each survey.

R2) Synthesize the results of individual surveys to determine if the effect sizes for each variable are similar between surveys (homogenous), and to determine if the overall effect size is both significant and in the direction expected based on previous literature.

META-ANALYSIS METHODS

R1: Calculating odds ratio (OR) for incidence of household-scale heat-related illness (HRI)

1. Identify shared questions between surveys
2. Convert survey questions as needed to binary responses
3. Control for household size in all calculations
4. Calculate OR of HRI for each survey variable individually
   Note: Aggregated HRI questions to binary household response

1. Have central AC
2. Too hot in home
3. Household income
4. Income below $20K
5. Cost of elect. limiting
6. Hispanic/Latino
7. Own home
8. Have window AC
9. Perceive nhood hotter
10. Live alone
11. Risk – climate change
12. Risk – extreme heat
13. Risk – summer temps
14. Cost of repairs limiting

Logistic regression model

$$log\left(\frac{Y}{1-Y}\right) = b_o + b_1x_1 + b_2x_2$$

Odds of HRI~survey question + HH size

R2: Using meta-analysis to synthesize survey responses in relation to heat-related illness (HRI)

Synthesize effect sizes → "summary effect"

In a random-effects model, individual studies are weighted to minimize both **within study variance** and **between study variance**

Can quantify heterogeneity of effect sizes between studies:

T^2 – estimated between studies variance

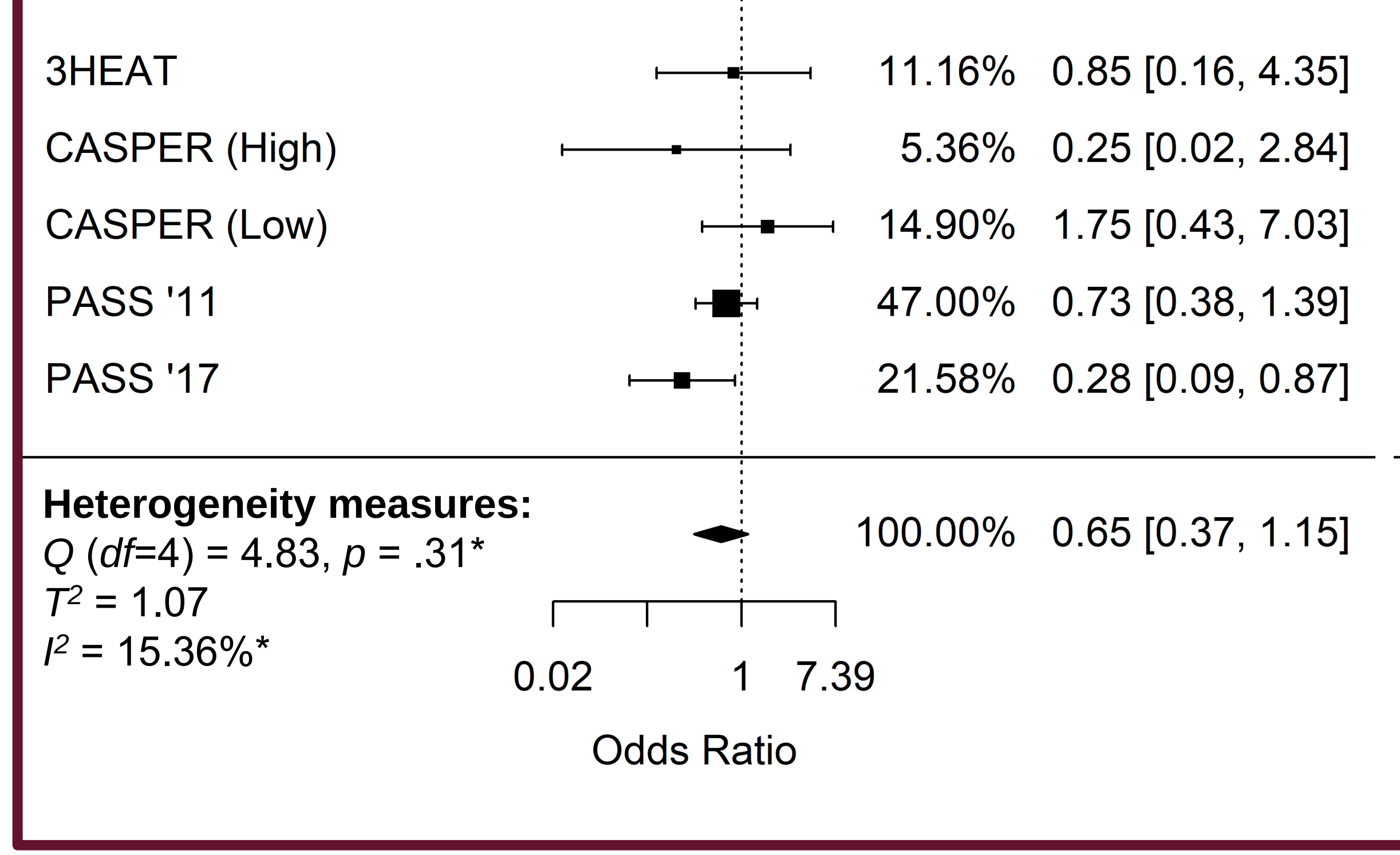
I^2 – proportion of observed variance that reflects real differences in effect size

Q – test statistic to assess certainty of apparent heterogenity

We used a random-effects meta-analysis model with restricted maximum-likelihood (REML) to estimate T^2

RESULTS OF META-ANALYSIS

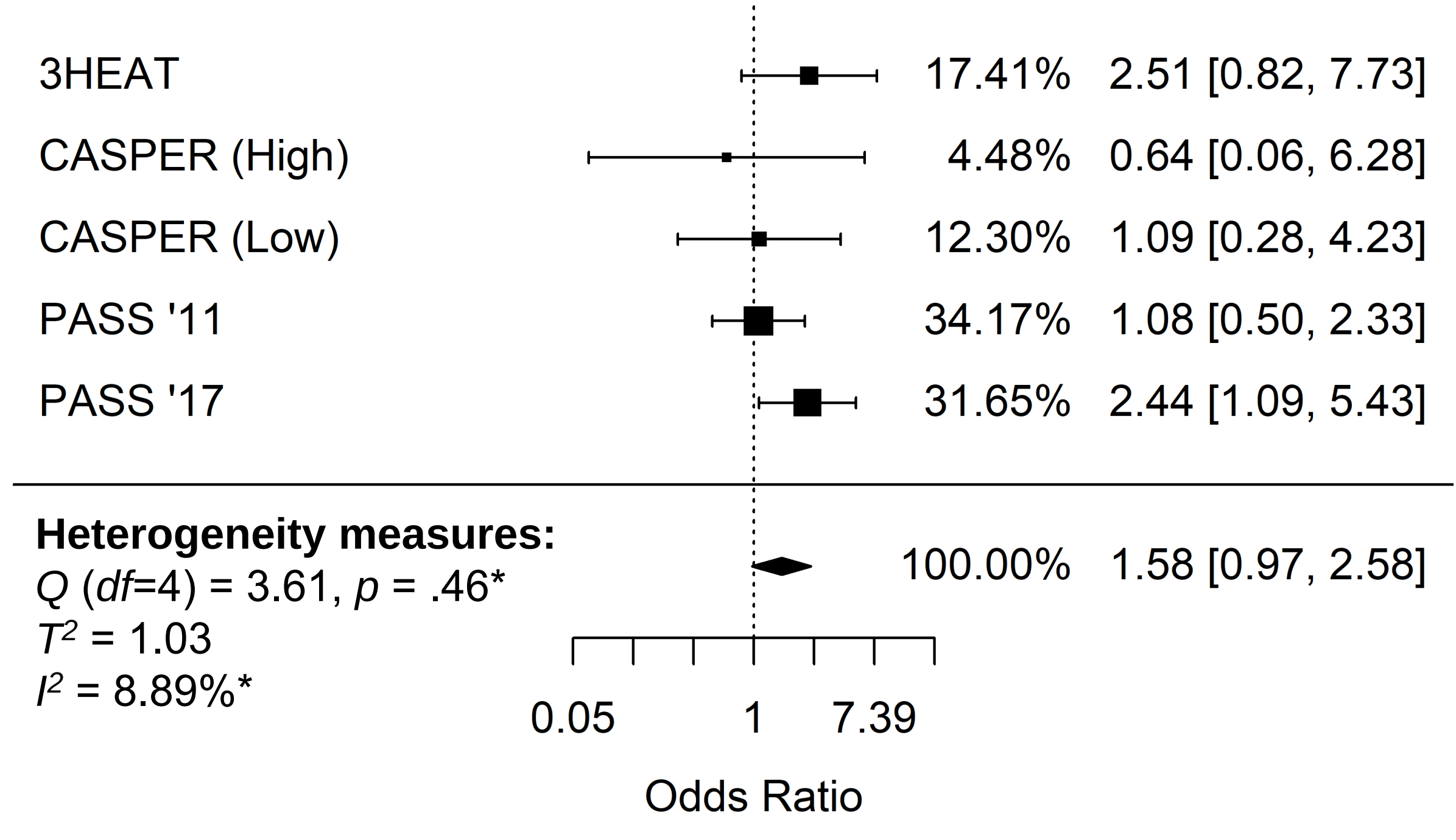
Have central A/C



3HEAT	11.16%	0.85 [0.16, 4.35]
CASPER (High)	5.36%	0.25 [0.02, 2.84]
CASPER (Low)	14.90%	1.75 [0.43, 7.03]
PASS '11	47.00%	0.73 [0.38, 1.39]
PASS '17	21.58%	0.28 [0.09, 0.87]
Heterogeneity measures:	100.00%	0.65 [0.37, 1.15]

Q (df=4) = 4.83, p = .31*
T^2 = 1.07
I^2 = 15.36%*

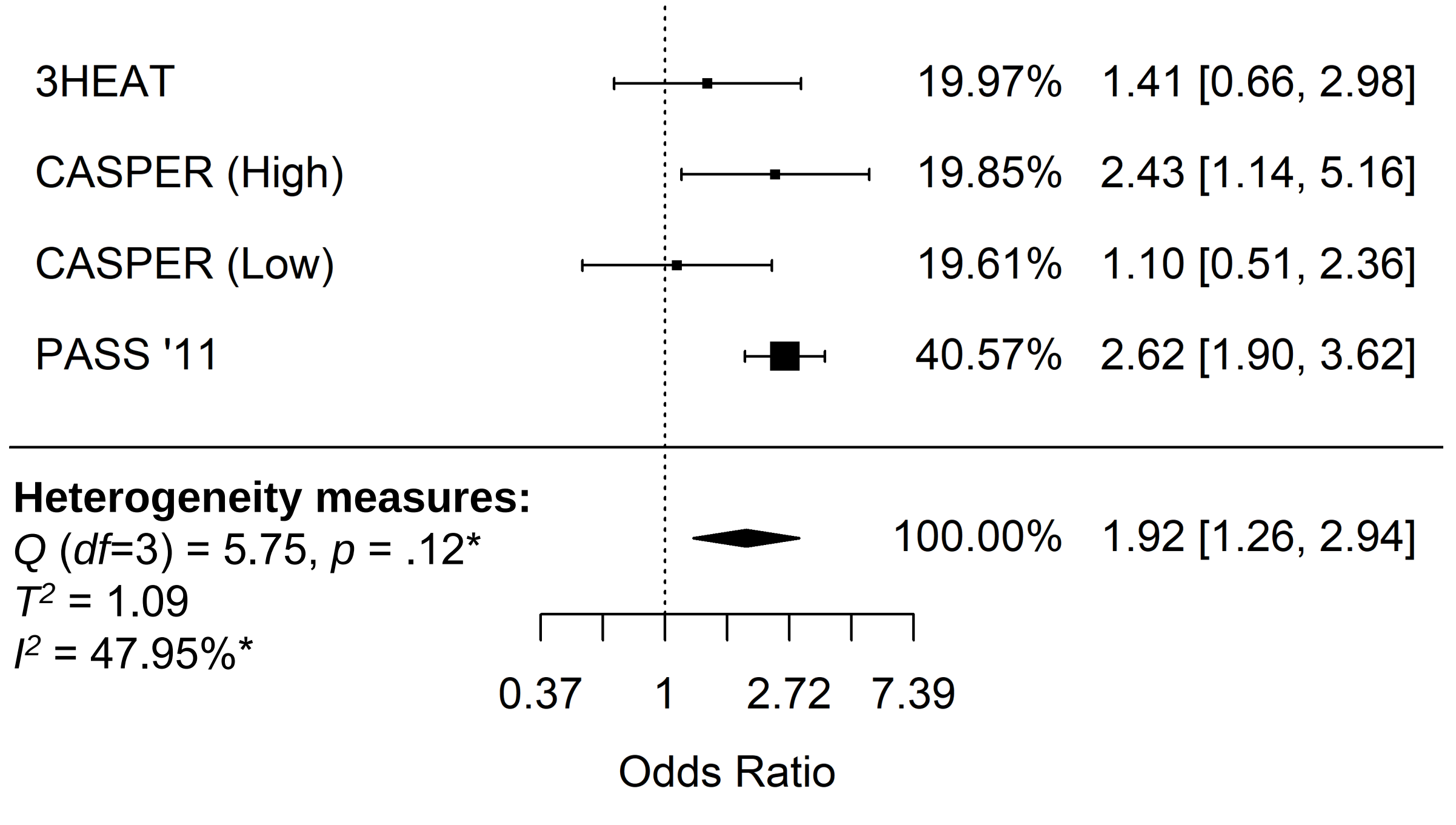
Have window A/C



3HEAT	17.41%	2.51 [0.82, 7.73]
CASPER (High)	4.48%	0.64 [0.06, 6.28]
CASPER (Low)	12.30%	1.09 [0.28, 4.23]
PASS '11	34.17%	1.08 [0.50, 2.33]
PASS '17	31.65%	2.44 [1.09, 5.43]
Heterogeneity measures:	100.00%	1.58 [0.97, 2.58]

Q (df=4) = 3.61, p = .46*
T^2 = 1.03
I^2 = 8.89%*

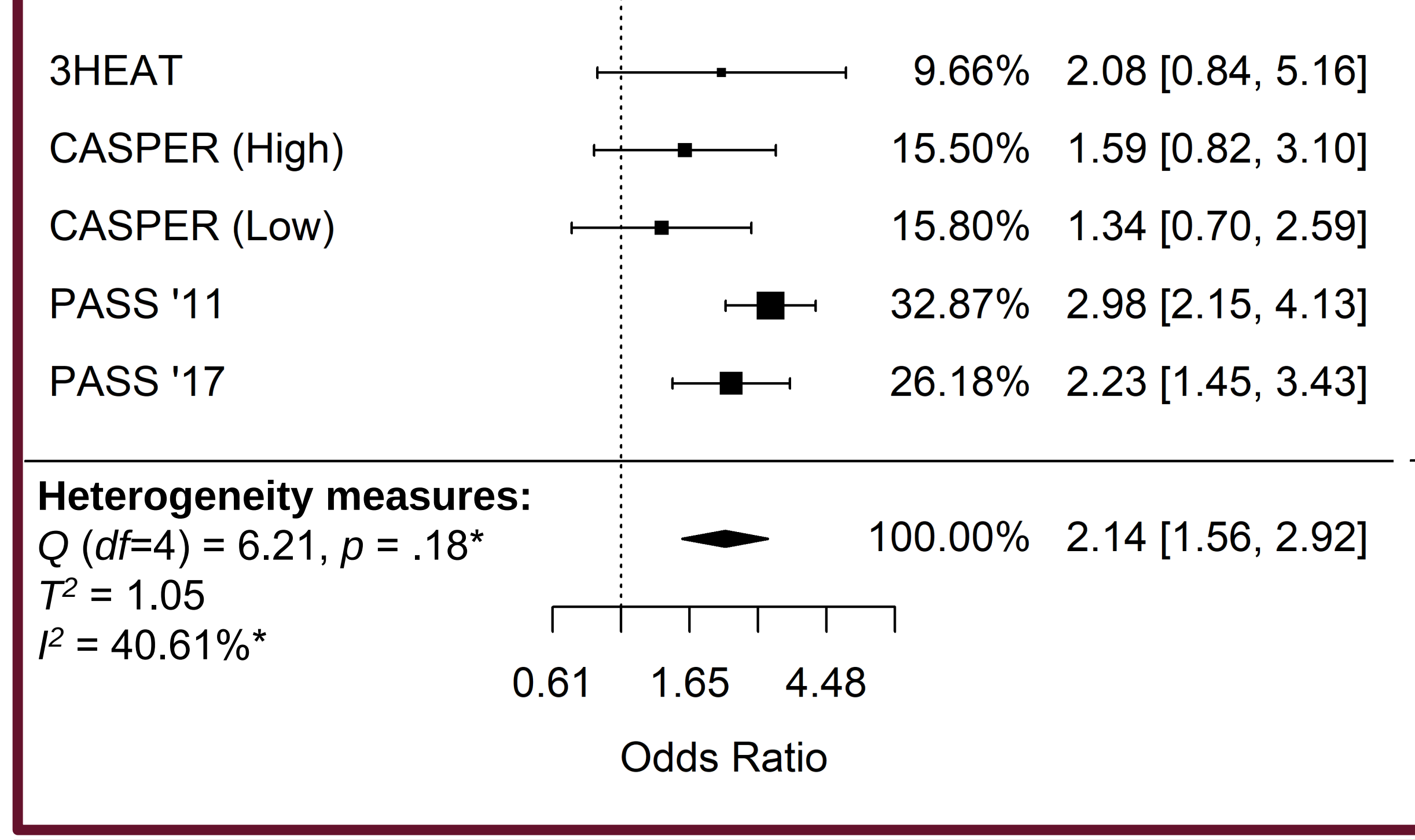
Cost of electricity limits A/C use



3HEAT	19.97%	1.41 [0.66, 2.98]
CASPER (High)	19.85%	2.43 [1.14, 5.16]
CASPER (Low)	19.61%	1.10 [0.51, 2.36]
PASS '11	40.57%	2.62 [1.90, 3.62]
Heterogeneity measures:	100.00%	1.92 [1.26, 2.94]

Q (df=3) = 5.75, p = .12*
T^2 = 1.09
I^2 = 47.95%*

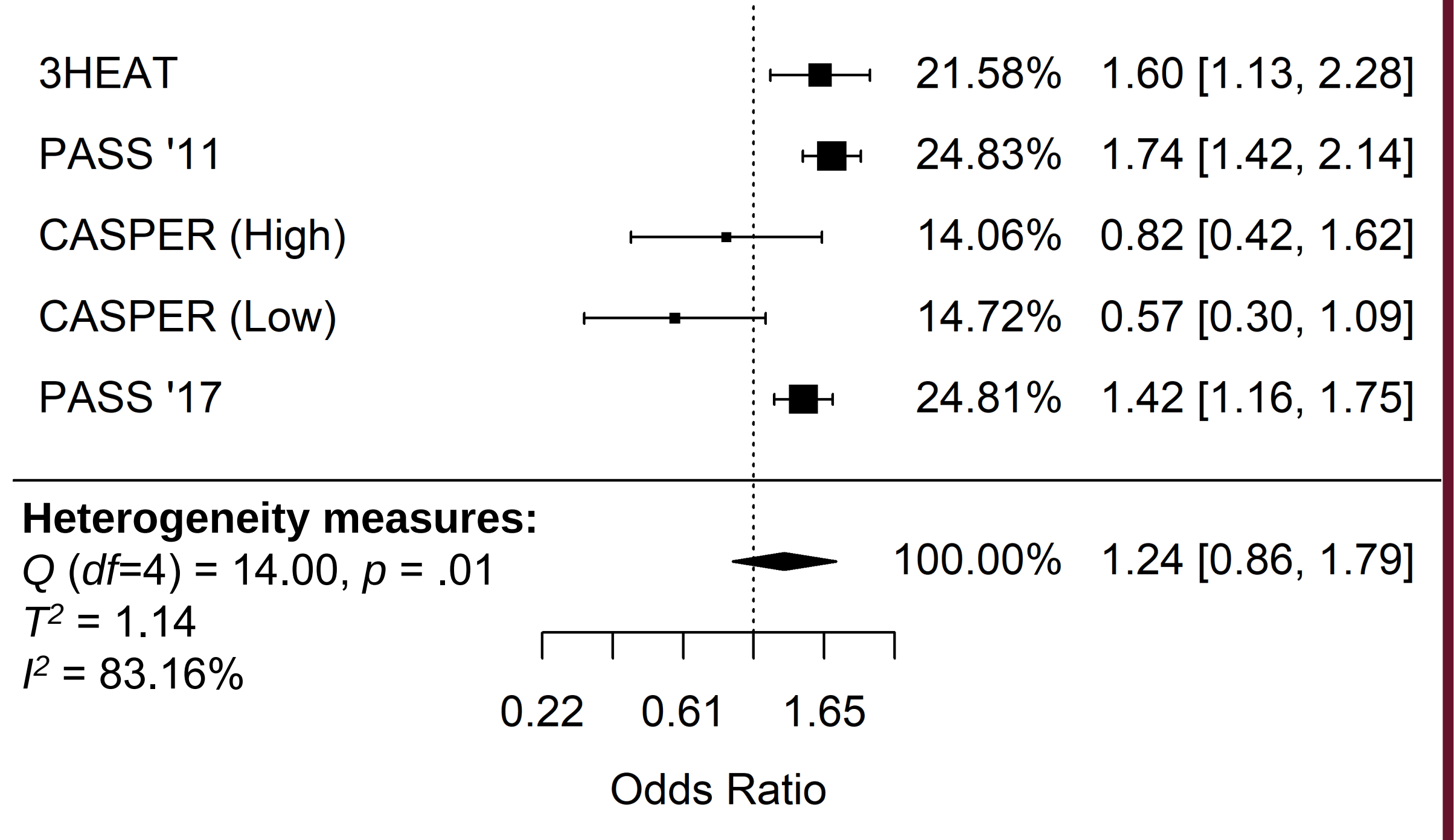
Too hot inside home during summer



3HEAT	9.66%	2.08 [0.84, 5.16]
CASPER (High)	15.50%	1.59 [0.82, 3.10]
CASPER (Low)	15.80%	1.34 [0.70, 2.59]
PASS '11	32.87%	2.98 [2.15, 4.13]
PASS '17	26.18%	2.23 [1.45, 3.43]
Heterogeneity measures:	100.00%	2.14 [1.56, 2.92]

Q (df=4) = 6.21, p = .18*
T^2 = 1.05
I^2 = 40.61%*

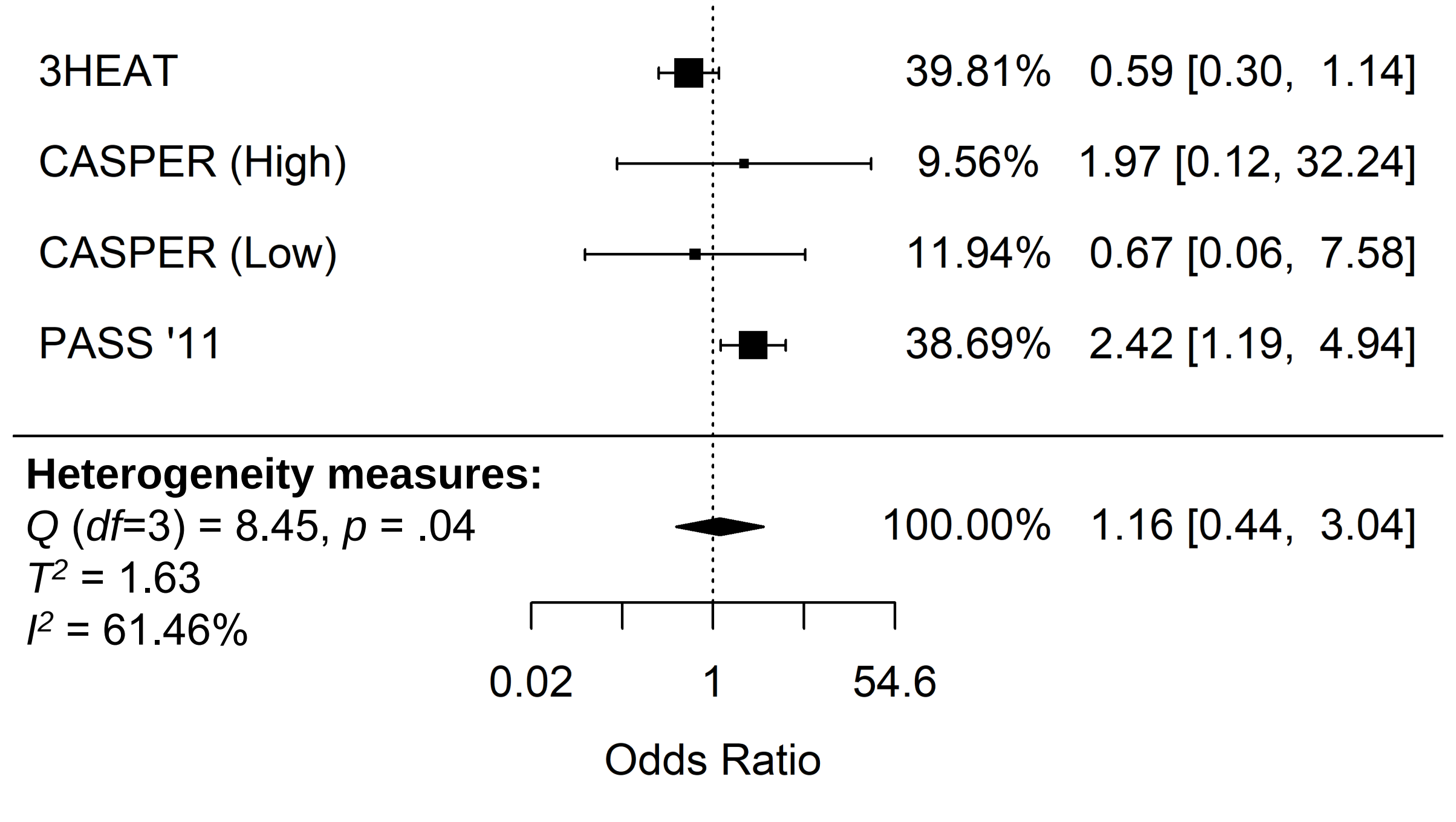
Risk perception – extreme heat



3HEAT	21.58%	1.60 [1.13, 2.28]
PASS '11	24.83%	1.74 [1.42, 2.14]
CASPER (High)	14.06%	0.82 [0.42, 1.62]
CASPER (Low)	14.72%	0.57 [0.30, 1.09]
PASS '17	24.81%	1.42 [1.16, 1.75]
Heterogeneity measures:	100.00%	1.24 [0.86, 1.79]

Q (df=4) = 14.00, p = .01
T^2 = 1.14
I^2 = 83.16%

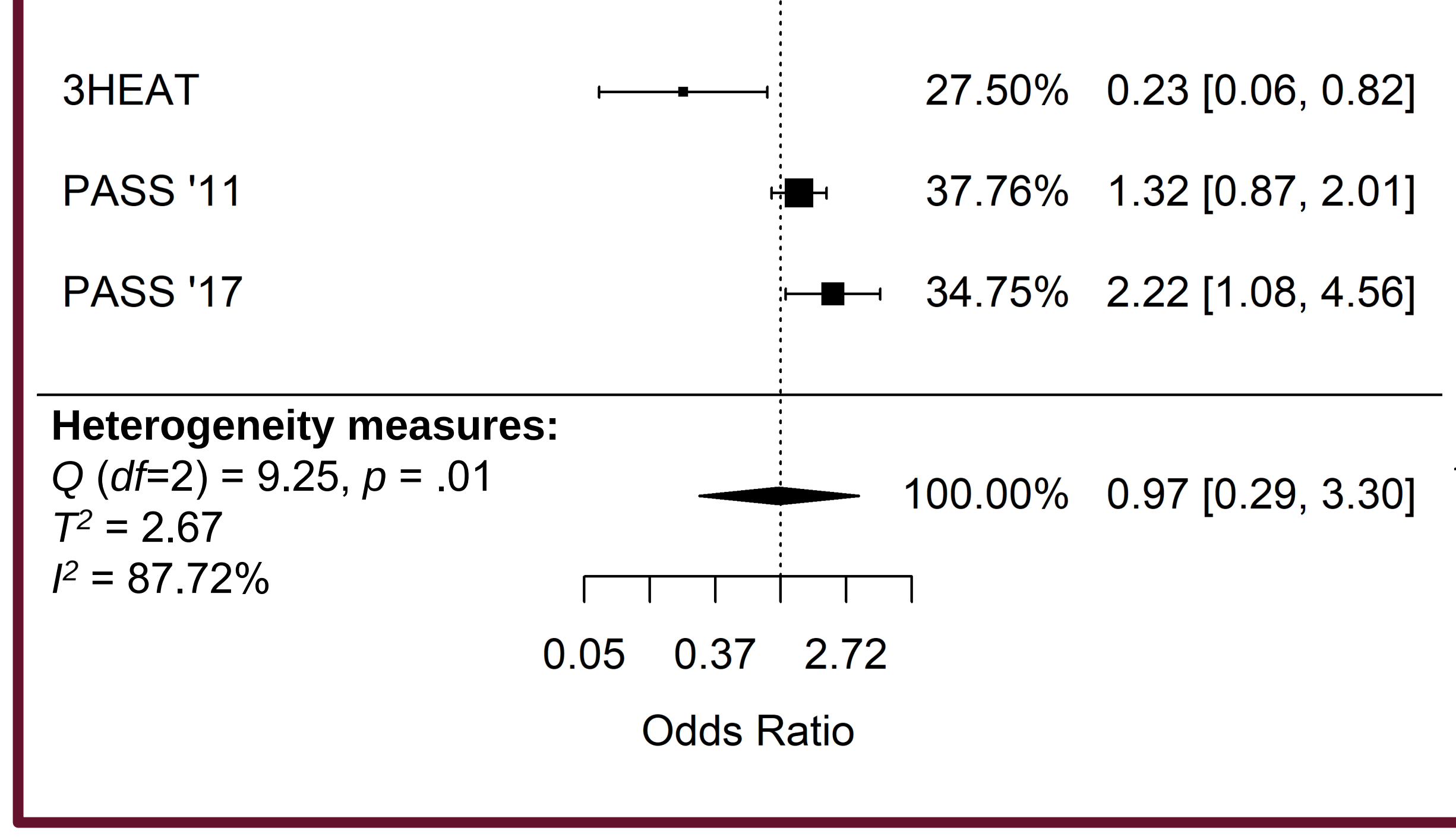
Cost of repairs limits A/C use



3HEAT	39.81%	0.59 [0.30, 1.14]
CASPER (High)	9.56%	1.97 [0.12, 32.24]
CASPER (Low)	11.94%	0.67 [0.06, 7.58]
PASS '11	38.69%	2.42 [1.19, 4.94]
Heterogeneity measures:	100.00%	1.16 [0.44, 3.04]

Q (df=3) = 8.45, p = .04
T^2 = 1.63
I^2 = 61.46%

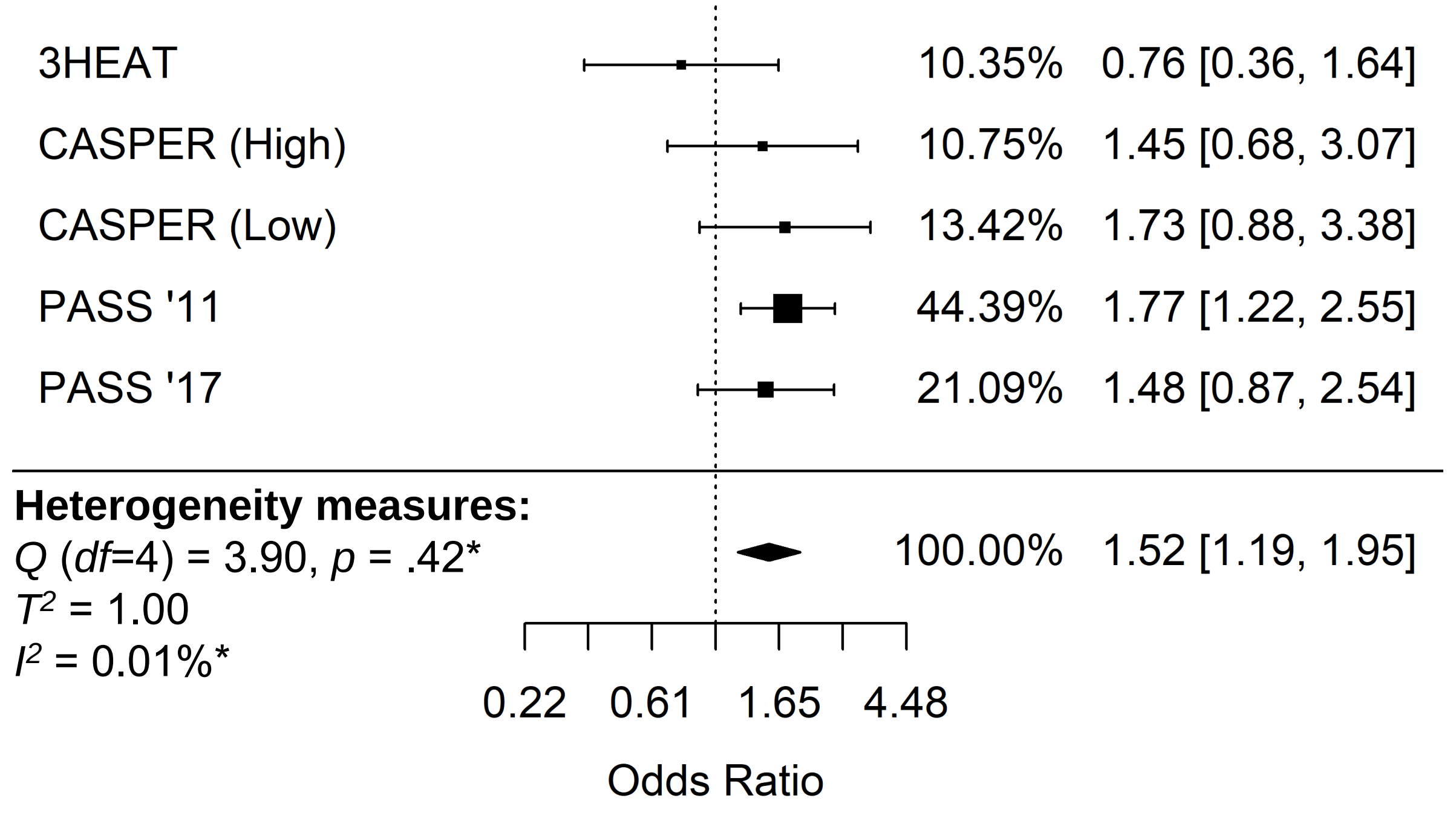
Household income <$20,000



3HEAT	27.50%	0.23 [0.06, 0.82]
PASS '11	37.76%	1.32 [0.87, 2.01]
PASS '17	34.75%	2.22 [1.08, 4.56]
Heterogeneity measures:	100.00%	0.97 [0.29, 3.30]

Q (df=2) = 9.25, p = .01
T^2 = 2.67
I^2 = 87.72%

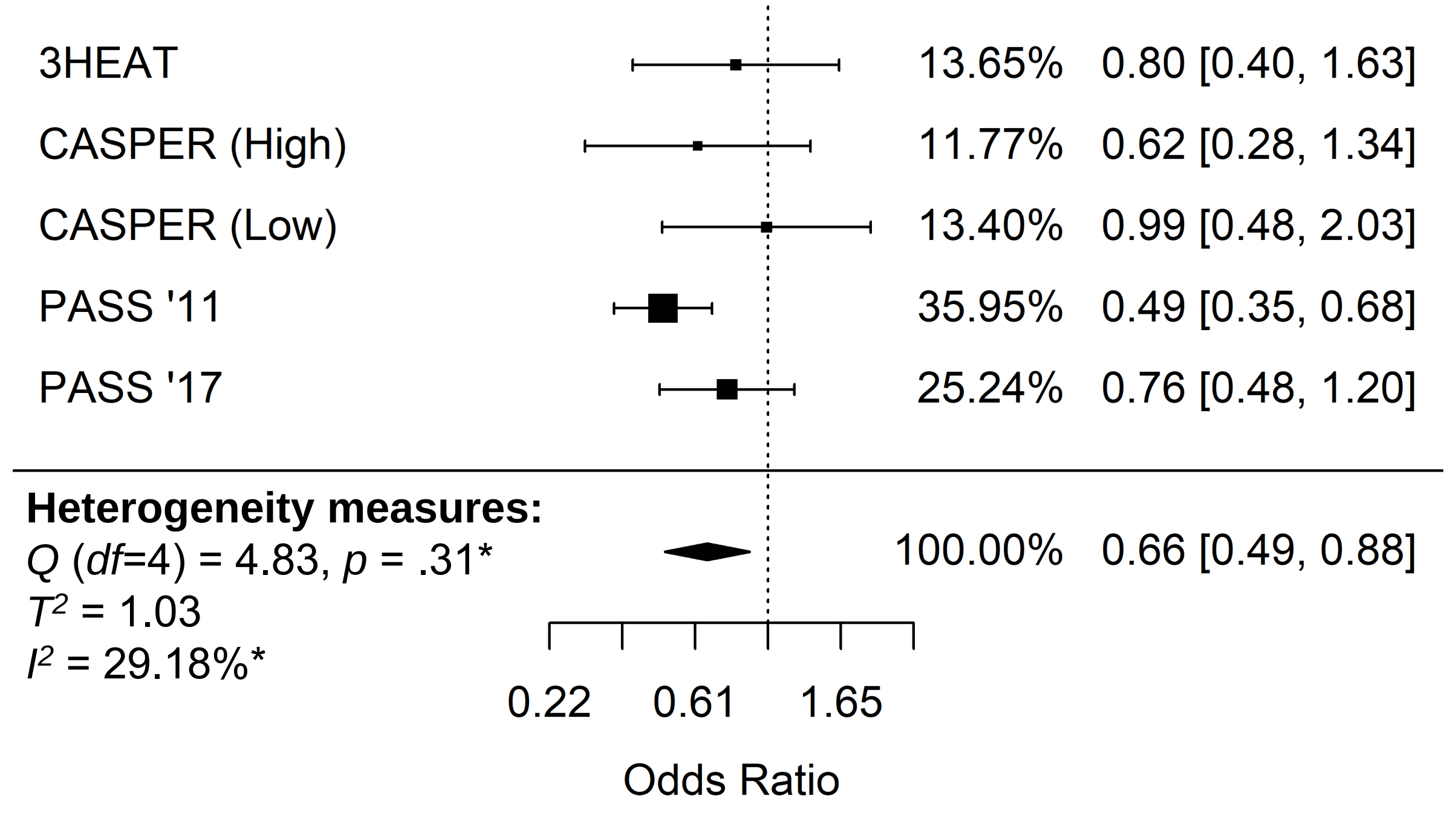
Hispanic/Latino



3HEAT	10.35%	0.76 [0.36, 1.64]
CASPER (High)	10.75%	1.45 [0.68, 3.07]
CASPER (Low)	13.42%	1.73 [0.88, 3.38]
PASS '11	44.39%	1.77 [1.22, 2.55]
PASS '17	21.09%	1.48 [0.87, 2.54]
Heterogeneity measures:	100.00%	1.52 [1.19, 1.95]

Q (df=4) = 3.90, p = .42*
T^2 = 1.00
I^2 = 0.01%*

Household owns home



3HEAT	13.65%	0.80 [0.40, 1.63]
CASPER (High)	11.77%	0.62 [0.28, 1.34]
CASPER (Low)	13.40%	0.99 [0.48, 2.03]
PASS '11	35.95%	0.49 [0.35, 0.68]
PASS '17	25.24%	0.76 [0.48, 1.20]
Heterogeneity measures:	100.00%	0.66 [0.49, 0.88]

Q (df=4) = 4.83, p = .31*
T^2 = 1.03
I^2 = 29.18%*

CONCLUSION

Individual surveys may only provide a partial perspective on residents' experience with heat; some survey variables (e.g. "Too hot in home" or "Hispanic/Latino") did not have significant effect sizes in the majority of individual surveys, but did have a significant summary effect.

Indoor exposure: the summary effect for "central A/C" was not significant, but the "limiting cost of electricity on A/C use" and being "too hot in the home" were significant, possibly indicating a greater nuance in the extent to which people are able to afford to use their A/C.

Demographic variables: Home ownership and Hispanic/Latino both had significant summary effects with good measures of homogeneity, while household income did not.

Limitations: The precision of estimation of T^2 is very sensitive to sample size. A small sample also limits use of techniques that might explain excess between study variance (like subgroup analysis or meta-regression).

ACKNOWLEDGEMENTS

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