The Predictive Validity of Static-99R Over 10 Years for Sexual Offenders in California:

2018 Update

Seung C. Lee

R. Karl Hanson

Carleton University

Nyssa Fullmer

Janet Neeley

Kerry Ramos

California Department of Justice

Summary:

- ➢ In California, Static-99R plays a vital role in determining offenders' treatment needs (e.g., dosage), and helps determine whether to use GPS monitoring.

- ➢ The purpose of this study was to update Hanson et al.'s (2014) study with a 10-year follow-up period.

- ➢ Overall, Static-99R worked well in discriminating between recidivists and non-recidivists within the fixed 10-year follow-up period.

- ➢ The 10- year sexual recidivism rates in this California sample were analogous to the sexual recidivism rates of other studies.

- ➢ The results support the continued use of Static-99R in California for 10-year risk prediction.

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California was the first state in the nation to require convicted sex offenders to keep local law enforcement agencies informed of their whereabouts.[1] California's sex offender registry was established in 1947. As of March 14, 2018, the California sex offender registry had 105,825 registrants (not including those residing out-of-state or who have been deported). Since 2006, California law requires the use of empirical risk assessment of convicted sex offenders in California before sentencing. On September 20, 2006, Senate Bill 1128, the Sex Offender Punishment, Control, and Containment Act, became law (Pen. Code §§ 290.03-07). The goal of this newly adopted law was to create a standardized system used to identify, assess, monitor and contain sex offenders in California (Pen. Code §290.03, subd. (b)).

The law established a committee called the SARATSO (State Authorized Risk Assessment Tools for Sex Offenders) Committee that consists of representatives from the California Department of State Hospitals, Department of Corrections and Rehabilitation (CDCR), and the Attorney General's Office (Pen. Code §290.05). The primary goal of the SARATSO committee is "to ensure that the SARATSO reflects the most reliable, objective, and well-established protocols for predicting sex offender risk of recidivism, has been scientifically validated and cross-validated, and is, or is reasonably likely to be, widely accepted by the courts." (Pen. Code §290.04, subd. (a)(2)). The SARATSO Committee must ensure that all selected risk assessment instruments for sex offenders are continuing to accurately predict recidivism, and provide expert training to ensure consistency (inter-rater reliability) and accuracy in scoring the risk assessment instruments.

In 2007, the SARATSO Committee adopted the Static-99[2] as the state-authorized risk assessment instrument for registered adult male sex offenders. The Static-99 is an actuarial risk assessment tool, which relies on 10 static risk factors, related to demographic information, criminal history, and victim information. Because it does not include items related to diagnoses or mental health status, trained individuals (but not necessarily clinicians) can accurately score the tool.[3] In California, probation officers and personnel from the California Department of Corrections and Rehabilitation are trained by SARATSO experts to score the Static-99R[2,4] (the current revised version of the Static-99).

California parole and probation departments use the Static-99R to assess the risk of sexual reoffending for offenders on community supervision. Static-99R scores play a vital role in determining offenders' treatment needs (e.g., dosage), and helps determine whether to use GPS monitoring. State law requires offenders on probation who are high risk according to the Static-99R to wear a GPS monitor.  All parolees who are required to register are required to wear a GPS during the period they are on parole. This blanket requirement for GPS monitoring of parolees was enacted by ballot initiative in California in 2006. Consequently, research to assess the continued effectiveness of the Static-99R and other risk assessment tools is important to ensure consistency and accuracy of the instrument.

Specifically, the primary role of the Static-99R is to inform decision-makers about the recidivism likelihood of sexual offenders after release into the community (i.e., a criterion-referenced, prognostic measure). Given the routine reliance on the Static-99R, it is important that there is evidence to support the major interpretations of the scores. There are two main interpretations of Static-99R scores, one related to an individual's relative risk (i.e., how likely the individual is to reoffend compared to other offenders) and another interpretation related to

absolute risk (i.e., the proportion of individuals with this score expected to reoffend within a defined time period).

Relative risk, or *discrimination*, states that sexual offenders with a higher Static-99R score are more likely to reoffend than individuals with a lower Static-99R score. The extent of these differences are described by odds ratios, risk ratios, or by the area under the curve (AUC) in receiver operating characteristics curve analysis (see Method section for further information concerning these statistics). For example, the user manual for Static-99R states that sex offenders with a score of 6 on the Static-99R have a sexual recidivism rate that is 3.77 times higher than the rate of offenders who are in the middle of the risk distribution (i.e., a Static-99R score of 2).[5] Researchers have widely studied the discriminative accuracy of Static-99R and have found that the scale demonstrates good discrimination (i.e., AUC = .70, $n$ = 8,106, $k$ = 23; odds ratio = 1.34, $n$ = 5,692, $k$ = 21).[6]

The norms of Static-99R[7] also provide the estimated probability of sexual reoffending linked to each score (i.e., absolute risk interpretation). With a score of 6, for example, the 5-year sexual recidivism rate for sexual offenders is 20.5%. The absolute predictive accuracy of a scale, or *calibration*, can be assessed by examining how well the estimated recidivism probability from the scale's norms corresponds with the observed recidivism probability of a new sample. The calibration of the Static-99R has only been a focus of research of a limited number of studies, and the results have not always been consistent.[7] For a comprehensive evaluation of the predictive validity of a scale, however, both relative and absolute predictive accuracy should be considered.

Since the Static-99R was adopted by the State of California, it has been the focus of several research studies. In 2014, researchers examined the predictive validity of Static-99R

using a sample of paroled sex offenders in California ($N = 475$).[8] The results of Hanson and colleagues' (2014) research indicated that the Static-99R had good discrimination across a range of ethnic groups (AUCs of .75 to .86; White, Black, Hispanic), as well as good calibration (*E/O* = 1.30 [0.87, 1.96]) when compared with the Static-99R norms. Given the modest size of the overall sample and the small number of recidivists in the subgroup analyses, further research with larger samples was needed to make strong conclusions concerning the predictive validity for Static-99R in California for diverse ethnic populations.

In 2016, the predictive validity of Static-99R in a new and larger sample was examined (*n* = 1,198 parolees and *n* = 428 probationers).[9] Lee and colleagues (2016) also found that the Static-99R had good relative predictive accuracy in two different forensic samples (AUCs of .78 for parolees and .72 for probationers). The overall sexual recidivism rate for the probationer samples was very similar to the recidivism rate of the norm population of the Static-99R (*E/O* = 1.26 [.86, 1.85]; however, the parole sample had a significantly lower rate of recidivism than the norm population (*E/O* = 1.96 [1.47, 2.54]).

In addition, the predictive validity of the Static-99R across three major ethnic groups (e.g., White, Black, and Hispanic) was evaluated using a combined sample of 2,101 sexual offenders from two studies conducted in 2014 and 2016.[9,10] The discrimination of Static-99R across ethnic groups were generally good to excellent, with the largest value for White and the lowest for Hispanic (AUCs of .70 to .82). Sexual recidivism base rates (at a score of 2) across ethnic groups were very similar, but were significantly lower than norms (*E/O* = 1.68 [1.39, 2.04]). The overall sexual recidivism rate of Hispanic sex offenders was substantially lower than the norm population (i.e., poor calibration; *E/O* = 2.33 [1.54, 3.55]) as compared to individuals of White or Black ethnicity.

Although previous California research has supported the predictive accuracy of the Static-99R, none of the studies have extended beyond 5-year follow-up time. Given the potential long-term influence of the risk assessment tool, however, it is valuable to examine how it performs over longer time periods (e.g., more than 5 years).

A related question is the extent to which recidivism risk changes during long follow-up periods. Previous research has found the risk of sexual recidivism predictably declines the longer individuals remain sex offense-free in the community.[11] Although the cumulative sexual recidivism rate increased over time, the sexual recidivism rate halves every 5-year offense-free in the community (e.g., 9.1% up to 5-years and 4.1% between 5 to 10 years).[12] Consequently, it would valuable to know whether similar effects are observed in California.

The current study is a follow-up to the 2014 study[8], which assessed sexual recidivism rates five years after release from prison (entitled "*The Field Validity of Static-99/R Sex Offender Risk Assessment Tool in California*"). There are two parts. Part 1 was the update on the previous study ($n = 475$; Hanson et al., 2014) with a fixed 5-year follow-up period. Specifically, the main update was to utilize California Sex and Arson Registry records in addition to criminal history records in order to capture risk assessment history, death and deportation information, and sex offender registry status. Another update was the use of the new standardized risk categories of Static-99R: Level I – very low risk (scores of -3 to -2), Level II – below average risk (scores of -1 to 0), Level III – average risk (scores of 1 to 3), Level IVa – above average risk (scores of 4 to 5), and Level IVb – well above average risk (score 6 or higher).[13] The main purpose of Part 1 was to re-analyze discrimination and calibration of Static-99R with the updated information. The primary research question was how the extraneous factors (e.g., additional information, such as

deportation and death) influenced the predictive accuracy (discrimination and calibration) of the Static-99R.

Part 2 of this study evaluated the predictive validity of Static-99R over a 10-year follow-up period. The primary research questions were the following:

1) Does the Static-99R scale predict sexual recidivism for a 10-year follow-up period (discrimination) across different ethnic groups (White, Black, and Hispanic)?

2) Does the predictive accuracy of Static-99R change over time for 10-year follow-up period (time-dependent discrimination)?

3) Are there any significant differences in sexual recidivism rates for 10-year within ethnic groups?

4) Are the observed sexual recidivism rates for 10-year comparable to those from other 10-year follow-up studies?

5) Does the risk of sexual recidivism decline the longer individuals remain sex offense-free in the community (i.e., offense-free effect)?

## Method

**Sample**

**Part 1.** This study included adult male sexual offenders released from the California Department of Corrections and Rehabilitation (CDCR; i.e., parolees) between 2006 and 2007. Of the 541 cases, 145 were eliminated because 26 died and 129 were deported before five years after release. Also, 25 were eliminated because their last sex offense was greater than two years prior to the index non-sexual offense (Figure 1). The rationale was that "For offenders with two years or more sex offense-free in the community since release from the index offense, the time

they have been sex offense-free in the community should be considered in the overall evaluation of risk" (Phenix et al., 2016, pp. 13-14).[14]

Of the remaining 371 offenders, 39.4% ($n = 146$) were White, 27.5% ($n = 102$) were Black, 25.6% ($n = 95$) were Hispanic, and 7.5% ($n = 28$) were Other/Unknown. The average age of the offenders at release was 42.8 years ($SD = 10.8$, range from 20.6 to 86.6 years). The 5-year sexual recidivism rate was 6.2% (23/371).
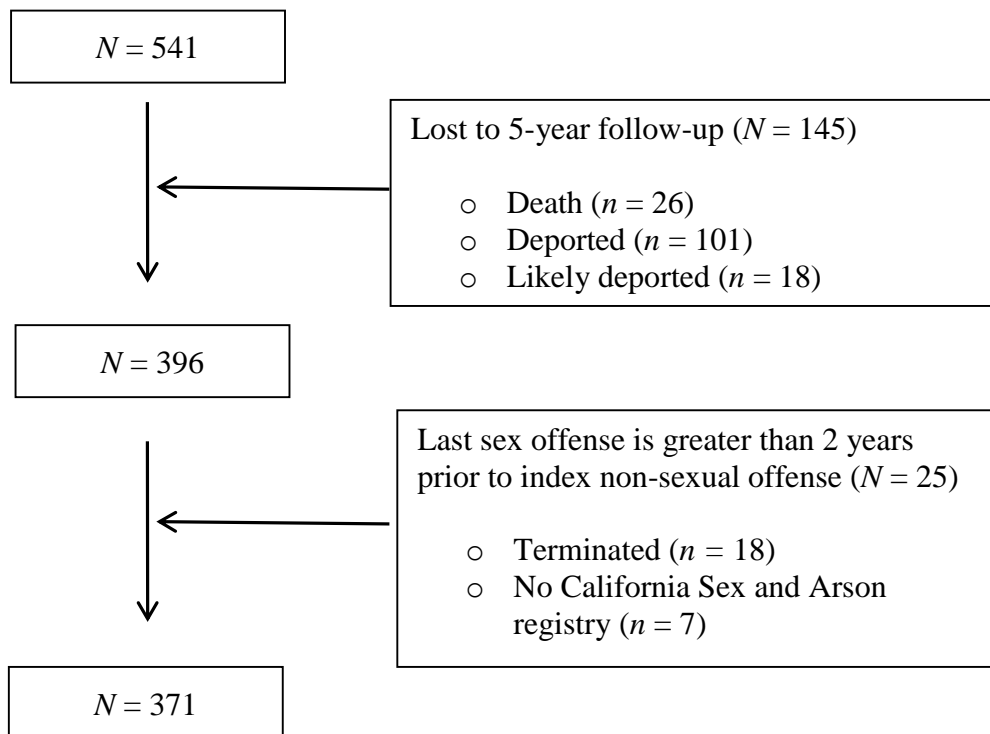


*Figure 1.* The sample in Part 1 study with a fixed 5-year follow-up period (Sexual recidivism rate was 6.2%; 23/371).

**Part 2.** The initial samples in Part 2 was the same as for Part 1, namely adult male sexual offenders released from the California Department of Corrections and Rehabilitation (CDCR; i.e., parolees) between 2006 and 2007. Of the 541 cases, 16 were eliminated because they had less than a 10-year follow-up time and 165 were eliminated because of death (45) or deportation

(120) prior to 10 years after release. In addition, 22 were eliminated because their last sex offense is great than two years prior to the index non-sexual offense (Figure 2).

Of the remaining 338 offenders, 39.1% ($n = 132$) were White, 27.5% ($n = 93$) were Black, 25.1% ($n = 85$) were Hispanic, and 8.3% ($n = 28$) were Other/Unknown. The average age of the offenders at release was 42.0 years ($SD = 9.8$, range of 20.6 to 76.5). The 10-year sexual recidivism rate was 10.4% (35/338).
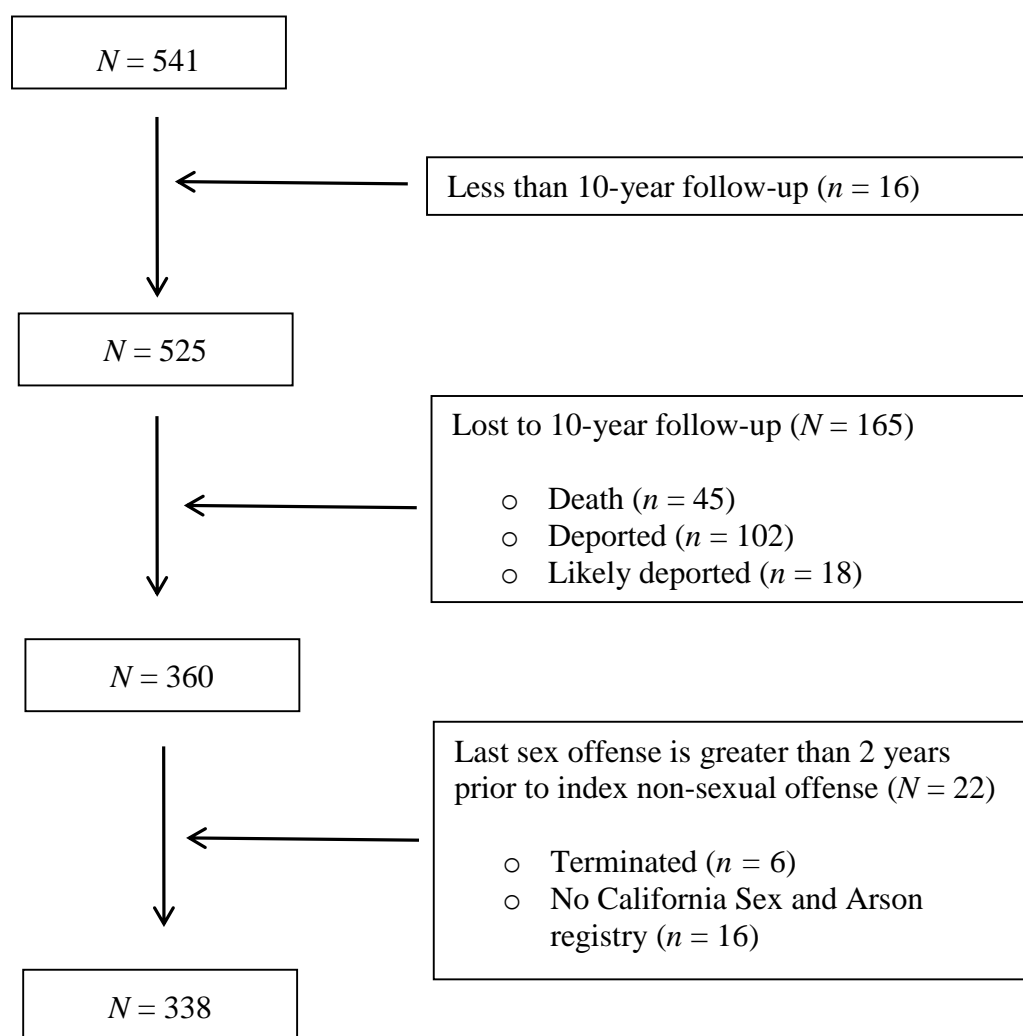


*Figure 2*. The sample in Part 2 study with a fixed 10-year follow-up period (Sexual recidivism rate was 10.4%; 35/338).

**Measures**

      **Static-99R.**[3,5] Static-99R is a 10-item empirical actuarial risk tool designed to predict sexual recidivism among adult male offenders. Static-99R is identical to Static-99 except that it contains revised age weights. The total score (ranging from -3 to 12) is calculated by summing all item points and can be used to place offenders in one of five risk categories: Level I - very low risk (scores of -3 to -2), Level II - below average risk (scores of -1 to 0), Level III - average risk (scores of 1 to 3), Level IVa - above average risk (scores of 5 to 6), and Level IVb - well above average risk (scores of 6 or higher).[13] For individuals originally scored on Static-99, Static-99R scores were computed from Static-99 scores by using the offender's date of birth to calculate the updated age item.

      **Inter-Rater Reliability**. Rater reliability was not examined in the current sample. A previous study[7] found overall good interrater reliability (ICC = .78, [.64, .90]) for Static-99R total score in a sample of 55 California parole and probation officers (ICC = .81, $n = 30$; ICC = .77, $n = 25$, respectively).

      **Recidivism.** Recidivism was defined as any subsequent arrest for a sexual offense (contact or non-contact) after released on community supervision as parolees from the California Department of Corrections and Rehabilitation (CDCR). Sexual offenses were categorized into contact and non-contact based on descriptions provided in California's Penal Code. Violations of the sex offender registration law were counted separately and categorized as nonsexual offenses. Also, indecent exposure and child pornography recidivism were counted separately and categorized as non-contact sexual recidivism.

**Procedure**

The subjects were scored on the Static-99/R as part of routine practice for applied decision-making when they were released from CDCR between the years of 2006 and 2007. The California Department of Justice provided recidivism information for the five-year period of March 2012 through March 2017. The earlier study conducted in 2014 looked at recidivism information from the same sample for the five-year period of March 2007 through March 2012. The current study utilized California Sex and Arson Registry records in addition to criminal history records in order to capture risk assessment history, death and deportation information, and their status on the sex offender registry.

Age at time of re-offense was recorded for those who reoffended with sexual offenses. Incarceration history was used to calculate age at the time of sexual re-offense and time in the community between sexual offenses. Information about admittance to a California Department of State Hospitals facility was recorded to examine the relationship between mental illness and recidivism.

**Plan of Analysis**

Assessing the predictive accuracy of a risk scale requires considering calibration (correspondence between expected and observed recidivism rates) as well as discrimination (how different are recidivists from non-recidivists?) For discrimination, we used three statistical methods: 1) the area under the curve (AUC) from receiver operating characteristic (ROC) analysis[15], 2) Harrell's C index [16], and 3) odds ratios from logistic regression.[17] For calibration, we used two indices: 1) $E/O$ index[18] (the ratio of expected number of recidivists divided by an observed number of recidivists) and 2) fixed-effect meta-analysis of logistic regression

parameters.[19,20] For the time-dependent discrimination analyses we used a) time-dependent AUC analysis[21] and b) the Schoenfeld residuals test.[22]

**Area Under the Curve (AUC)**. AUC values indicate the probability that a randomly selected recidivist would have a more deviant score than a randomly selected non-recidivist. AUC can vary between 0 and 1, with .50 indicating the level of prediction that would be expected by chance. According to Rice and Harris,[23] AUCs of .56 would be considered small, .64 would be moderate, and .71 would be large. AUC values are expected to be smaller in prognostic studies than in diagnostic studies because the outcome of interest in prognostic studies does not exist at the time of assessment, and may never happen.[24] The AUC has an advantage of insensitivity to base rates and robustness to outliers.[25]

**Harrell's C index.** For outcome variables with varying follow-up time, Harrell's C index[16] is a recommended statistic to measure discrimination accuracy because it has increased statistical power over the AUC. Harrell's C is similar to AUC analysis, with values interpreted as the probability that of two randomly selected offenders, the offender with a higher risk score will reoffend before the other. Harrell's C also can vary between 0 and 1, with .50 indicating the level of prediction that would be expected by chance. The same benchmarks of AUCs are applicable (e.g., effect of .56 is small, .64 is moderate, and .71 is large).[26]

**Odds ratios.** Odds ratios indicate the change in relative risk associated with one unit change in Static-99/R scores. For example, Static-99R scores are associated with a consistent relative risk increase of approximately 1.45,[7] which means the rate of recidivism increases 1.45 times as each Static-99R score increases. The primary advantage is that it is less affected by a restriction of range compared to AUCs.[27]

*E/O* **index.** The *E/O* index is a measure of calibration in which the expected number of

recidivists is divided by an observed number of recidivists. Perfect calibration is indicated by an

*E/O* index of 1.0. Following Rockhill, Byrne, Rosner, Louie, and Colditz (2003),[28] the 95%

confidence intervals for the *E/O* indices were computed as follows:

$$95\% \, \mathrm{CI}(E/O) = (E/O) \exp\!\left(\pm\, 1.96\sqrt{1/O}\right)$$

The expected number of recidivists was based on the 5-year sexual recidivism rates for

routine/complete samples reported by Hanson, Thornton, Helmus, and Babchishin (2016).[7]

**Comparing Logistic regression parameters.** A second method of testing calibration

was to examine the extent to which logistic regression parameters, such as intercept values

(centered on Static-99R scores of 2) differed from the logistic regression parameters for the 5-

year routine sample norms (Table 7: $B0_2$ = -2.827, *SE* = 0.079; *B1* = 0.368, *SE* = 0.025).[7]

Specifically, the $B0_2$ represents the expected recidivism rate for a Static-99R score of 2 ($p_2$) in

logit units ($\ln[p_2/\{1\text{-}p_2\}]$). Differences between the parameters in the current sample and those of

the norms were tested using fixed-effect meta-analysis.[19,20]

**Time-dependent AUC.** This is the extended version of AUC with time-dependent

calculations of sensitivity and specificity.[21] A series of time-specific AUC statistics are generated

at each event time, and then the events are updated across the follow-up period. In this study, the

time-dependent AUC was based on the estimation of incident sensitivity and dynamic specificity

under Cox regression model. The incident sensitivity is the probability that an individual has a

higher score than a threshold among the individuals who experience the event at time *t,* and the

dynamic specificity is the probability that an individual has a lower score than the threshold

among the individuals that remain event-free at the event time *t*.[29] Given a series of time-specific

calculation of sensitivity and specificity, Time-dependent AUC may change across the follow-up time.

**Schoenfeld Residuals Test.** Schoenfeld residuals[22] represent the deviance of the observed covariate values from the expected covariate values at each event time. The Schoenfeld residuals test examine the extent to which the slope of scaled residuals correlates with time. If the correlation (slope) is significantly different from zero, it indicates the violation of the proportional hazard assumption in Cox regression model. In other words, if the plot of Schoenfeld residuals against time shows a non-random pattern, it means that the predictive accuracy of the risk tool varies across the follow-up time.

## Results

## Part 1

After considering the updated deportation and death information, the overall sexual recidivism rate during the fixed 5-year follow-up period became 6.2% (23/371) vs. 4.8% (23/475) from Hanson et al. (2014) study.[8] Approximately 90% of the deportees were Hispanic. As a result, the sexual recidivism rate of Hispanic sex offenders within the fixed 5-year follow-up period increased to 5.26% (5/95) from 2.5% (5/200). Hispanic groups, however, still had marginally lower sexual recidivism rate than other groups (6.9% for both White and Black groups). Across the whole sample, the earliest recidivism event happened immediately after release (less than 1 month) and the latest was 10.1 years after release ($M = 3.7$ years). On average, the recidivists were 46 years old at the time of recidivism (range from 20.8 to 65.6).

**Discrimination**

The average Static-99R score was 2.4 ($SD = 2.3$). As can be seen in Table 1, Black sex offenders ($M = 2.82$) had the highest Static-99R score, and Hispanic sex offender had the lowest

score ($M = 2.03$). Across ethnic groups, however, the differences in the average Static-99R

scores was no more than would be expected by chance, $F (3, 367) = 2.24$, $p = 0.08$.

The overall discrimination was very similar to that observed in the previous California

study by Hanson et al. (2014).[8] Using the fixed 5-year follow-up, the AUC with any sexual

recidivism was 0.81 [0.70, 0.91]. Static-99R was able to discriminate recidivists from non-

recidivist for all ethnic groups (all AUCs > .72; Table 1) although the AUC for the Hispanic

group was not statistically significant due to the small number of recidivists. Specifically, White

group had the highest AUC value of .85 [.72, .98] and Hispanic had the lowest AUC value of .72

[.43, .99].

Table 1

*Five-year Sexual Recidivism Rates, Static-99R Scores, and AUC values for White, Black, and*

*Hispanic Sex Offenders*

| Racial groups | Sexual Recidivism Rates (%) | Number of recidivists/total | M (SD) | AUC | 95% C. I. | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| White | 6.85 | 10/146 | 2.29 (2.44) | **.852** | .724 | .980 |
| Black | 6.86 | 7/102 | 2.82 (2.10) | **.755** | .549 | .961 |
| Hispanic | 5.26 | 5/95 | 2.03 (2.25) | .723 | .431 | .999 |
| Other/Unknown | 3.57 | 1/28 | 2.14 (1.80) | **.981** | .927 | .999 |
| Total | 6.20 | 23/371 | 2.36 (2.27) | **.806** | .701 | .911 |

*Note.* Based on a fixed 5-year follow-up period.

In this sample, the relationship between Static-99R scores (centered on a score of 2) and

sexual recidivism acceptably fit a logistic distribution (i.e., Hosmer-Lemeshow test was not

significant: $\chi2 = 8.46$, $df = 5$, $p = .133$; $B0_2 = -3.554$, $SE = .349$; $B1 = .537$, $SE = .101$; Figure 3).

The 5-year sexual recidivism rates at score of 2 across all ethnic groups were very similar

(2.4 to 3.9; $Q_{between} = 0.33$, $df = 2$, $p = .847$; Table 2). Compared to the previous study, however,

the 5-year sexual recidivism rates at a score of 2 of Hispanic sex offenders increased to 3.9%

from 1.9% and became the highest (previously, it was the lowest).

The discrimination (change in relative risk) was highest for White sex offenders (odds

ratios = 1.44 to 1.86), but the differences between ethnic groups were not statistically significant

($Q_{between}$ = 0.908, $df$ = 2, $p$ = .635; Table 2).

Table 2

*Logistic Regression Parameters for Static-99R Predicting 5-Year Sexual Recidivism for White,*

*Black, and Hispanic Offenders*

| Racial group | Base rate (Static-99R score of 2 in logit units) | | Relative risk | | | 95% C.I. | |
|---|---|---|---|---|---|---|---|
| | $B0_2$ | *SE* | *B1* | *SE* | *OR* | Lower | Upper |
| White | -3.687 (2.4%) | .592 | .618 | .167 | **1.86** | 1.34 | 2.57 |
| Black | -3.461 (3.0%) | .628 | .477 | .174 | **1.61** | 1.15 | 2.27 |
| Hispanic | -3.207 (3.9%) | .586 | .367 | .212 | 1.44 | 0.95 | 2.19 |
| $Q$ ($df$ = 2) | 0.332, $p$ =.847 | | 0.908, $p$ = .635 | | | | |
| $I^2$ | .00 | | .00 | | | | |
| Average (fixed-effect) | -3.449 | .347 | .506 | .105 | **1.66** | 1.35 | 2.04 |

**Calibration**

The overall resulting logistic equation indicated a relative risk increase of 1.71 for each

increase in Static-99R score ($e^{.537}$ = 1.71), and an adjusted 5-year sexual recidivism rate of 2.8%

for a Static-99R score of 2 ($[1/\{1+e^{-(-3.554)}\}]$ = .0278. When compared to the norms (from Hanson,

et al., 2016)[6], the adjusted (score of 2) base rate was significantly lower ($B0_2$ of -3.55 vs. -2.83;

$Q_{between}$ = 4.13, $df$ = 1, $p$ = .042), and the discrimination was larger, but not significantly so ($B1$ =

.537 vs. .368; $Q_{between}$ = 2.59, $df$ = 1, $p$ = .107; Table 3).

Overall, the adjusted base rates ($B0_2$) of each ethnic group were lower than the norms (5.6%), but not significantly (2.4%, 3.0%, and 3.9%; all $p$-values > .05). Relative risk rates for each ethnic group were greater than or equal to the norms, but there was no significant difference among those values (all $p$-values > .05; Table 3).

Table 3

*Comparison Logistic Regression Parameters for Static-99R Predicting 5-Year Sexual Recidivism with Meta-Average (from Hanson et al., 2016)*

| | Meta-Average (Norms) | Overall | White | Black | Hispanic |
|---|---|---|---|---|---|
| Base rate | | | | | |
| $B0_2$ (*SD*) | -2.83 (.079) | -3.55 (.349) | -3.69 (.592) | -3.46 (.628) | -3.21 (.586) |
| $Q_\Delta$ (*df* = 1) | | **4.13*** | 2.07 | 1.01 | 0.413 |
| Relative risk | | | | | |
| $B1$ (*SD*) | .368 (.025) | .537 (.101) | .618 (.167) | .477 (.174) | .367 (.212) |
| $Q_\Delta$ (*df* = 1) | | 2.59 | 2.19 | .383 | 0.001 |

*Note.* ***$p$ < .001, **$p$ < .01, * $p$ < .05.

In comparison to norms for routine samples, the observed 5-year overall recidivism rate in this updated sample was still lower (6.2% vs. 8.3%), although the difference was not significant (*E/O* index = 1.34 [0.89, 2.01]; Table 4). When comparing each of the five Static-99R risk categories (Table 4), only Level III (scores of 1, 2, and 3) showed significantly lower observed values than the expected values (2.2% vs. 5.8%; *E/O* index = 2.68 [1.01, 7.14]; Table 4).

Table 4

*Comparison of Expected and Observed 5-year Sexual Recidivism Rates for Static-99R*

*Standardized Risk Levels*

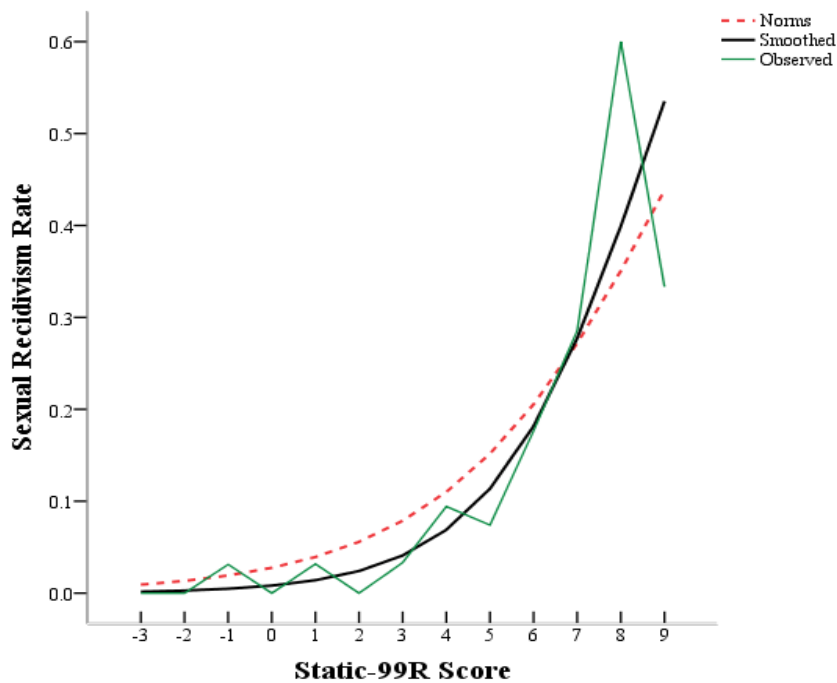| Risk Level | Sample size | Recidivists | | E/O index | 95% C.I. | |
| | | Observed (O) | Expected (E) | | Lower | Upper |
| --- | --- | --- | --- | --- | --- | --- |
| I | 7 | 0 (0.0%) | 0.08 | - | - | - |
| II | 71 | 1 (1.4%) | 1.72 | 1.72 | 0.24 | 12.2 |
| III | 186 | 4 (2.2%) | 10.72 | **2.68** | 1.01 | 7.14 |
| IVa | 74 | 8 (10.8%) | 9.19 | 1.15 | 0.57 | 2.30 |
| IVb | 33 | 10 (30.3%) | 9.09 | 0.91 | 0.49 | 1.69 |
| Total | 371 | 23 (6.2%) | 30.79 | 1.34 | 0.89 | 2.01 |



*Figure 3*. Observed and expected recidivism rates based on Static-99R 5-year sexual recidivism rates.

Figure 3 provides a plot of the observed recidivism rates per Static-99R risk score, the rates based on the smoothed logistic curve fitted to this data, and the recidivism rate norms for routine samples (Hanson et al., 2016).[7] As can be seen in Figure 3, the general pattern is that the

sexual recidivism rates were lower than expected, except for IVb category (scores of 6 or more; *E/O* index = 0.91 [0.49, 1.69]; Table 4).

For White sexual offenders, the observed 5-year overall recidivism rate was slightly lower than expected rate (6.8% vs. 8.4%; *E/O* index = 1.23 [0.66, 2.28]; Table 5 and Figure 4).

Table 5

*Comparison of Expected and Observed 5-year Sexual Recidivism Rates for Static-99R Standardized Risk Levels for White Sex Offenders*

| Risk Level | Sample size | Recidivists | | E/O index | 95% C.I. | |
| | | Observed (O) | Expected (E) | | Lower | Upper |
|---|---|---|---|---|---|---|
| I | 4 | 0 | 0.04 | - | - | - |
| II | 33 | 0 | 0.79 | - | - | - |
| III | 65 | 2 | 3.79 | 1.90 | 0.47 | 7.59 |
| IVa | 30 | 3 | 3.68 | 1.23 | 0.40 | 3.80 |
| IVb | 14 | 5 | 3.96 | 0.79 | 0.33 | 1.90 |
| Total | 146 | 10 | 12.27 | 1.23 | 0.66 | 2.28 |

For Black sex offenders, the observed 5-year overall recidivism rate was also lower than the expected rate, but not significantly (6.9% vs. 9.3%; *E/O* index = 1.36 [0.65, 2.86]; Table 6 and Figure 4).

Table 6

*Comparison of Expected and Observed 5-year Sexual Recidivism Rates for Static-99R Standardized Risk Levels for Black Sex Offenders*

| Risk Level | Sample size | Recidivists | | E/O index | 95% C.I. | |
| | | Observed (O) | Expected (E) | | Lower | Upper |
|---|---|---|---|---|---|---|
| I | 0 | 0 | 0 | - | - | - |
| II | 9 | 0 | 0.21 | - | - | - |
| III | 58 | 2 | 3.26 | 1.63 | 0.41 | 6.52 |
| IVa | 25 | 2 | 3.04 | 1.52 | 0.38 | 6.08 |
| IVb | 10 | 3 | 3.01 | 1.00 | 0.32 | 3.11 |
| Total | 102 | 7 | 9.53 | 1.36 | 0.65 | 2.86 |

For Hispanic sex offenders, the observed 5-year overall recidivism rate was lower than the expected rate, but not significantly (5.3% vs. 7.4%; *E/O* index = 1.41 [0.59, 3.38]; Table 7 and Figure 4).

Table 7

*Comparison of Expected and Observed 5-year Sexual Recidivism Rates for Static-99R Standardized Risk Levels for Hispanic Sex Offenders*

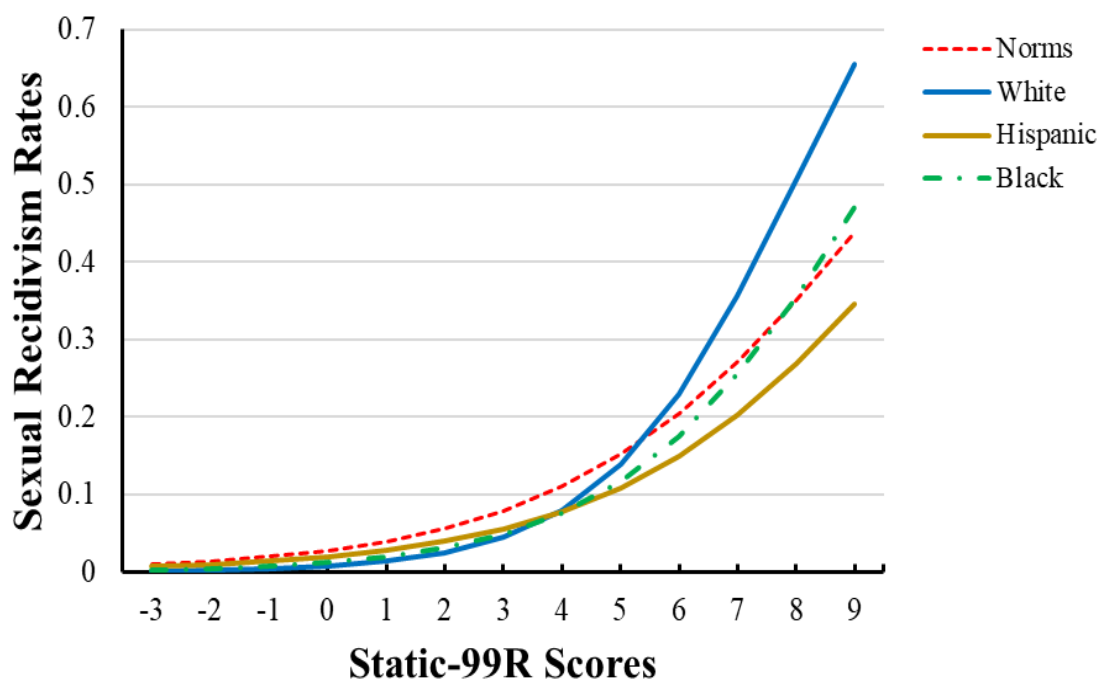| Risk Level | Sample size | Recidivists | | E/O index | 95% C.I. | |
| | | Observed (O) | Expected (E) | | Lower | Upper |
|---|---|---|---|---|---|---|
| I | 3 | 0 | 0.04 | - | - | - |
| II | 24 | 1 | 0.59 | 0.59 | 0.08 | 4.16 |
| III | 45 | 0 | 2.65 | - | - | - |
| IVa | 16 | 3 | 2.05 | 0.68 | 0.22 | 2.12 |
| IVb | 7 | 1 | 1.70 | 1.70 | 0.24 | 12.1 |
| Total | 95 | 5 | 7.03 | 1.41 | 0.59 | 3.38 |



*Figure 4*. Logistic curves for each ethnic group with the norms.

**Part 2**

The overall sexual recidivism rate during the fixed 10-year follow-up period was 10.4%

(35/338; Table 10). Specifically, 11 of 35 recidivists committed non-contact sexual offenses

(31%) and 24 of 35 recidivists committed contact sexual offenses (69%). There were very

similar sexual recidivism rates across the ethnic groups (10.6% to 11.8%; Table 9). We found the

expected offense-free effects on reducing the risk for sexual recidivism. The sexual recidivism

rate between Year 5 and Year 10 was 3.8%, which is approximately half of the rate observed

from time of release to Year 5 (6.2%).

Table 8

*Observed 10-year Sexual Recidivism Rates and Logistic Smoothed Recidivism rates for Static-*

*99R Standardized Risk Levels*

| Risk Level | Number of recidivists/ Total | Observed Recidivism rates (%) | Logistic Smoothed Recidivism rates (%) |
|------------|------------------------------|-------------------------------|----------------------------------------|
| I | 0/3 | 0.0 | 0.81 |
| II | 3/66 | 4.55 | 2.24 |
| III | 8/169 | 4.73 | 6.35 |
| IVa | 11/68 | 16.18 | 15.66 |
| IVb | 13/32 | 40.63 | 37.88 |
| Total | 35/338 | 10.36 | 10.36 |

**Discrimination**

The average Static-99R score was 2.4 ($SD = 2.3$). As can be seen in Table 8, Black sex

offenders ($M = 2.85$) had the highest Static-99R score, and Hispanic sex offenders had the lowest

score ($M = 2.11$). Across ethnic groups, however, there were no significant differences in the

average Static-99R scores, $F (3, 334) = 1.84$, $p = 0.14$.

Within a fixed 10-year follow-up, the overall AUC with any sexual recidivism was 0.75 [0.65, 0.85] and Harrell's C was .74 [.65, .84]. For each ethnic group, White sex offenders showed the highest AUC value of .85 [.74, .96] and Harrell's C of .83 [.68, .98] and Hispanic sex offenders had moderate AUC of .70 [.48, .91] and Harrell's C of .69 [.51, .87]. For Black sex offenders, the values of AUC and Harrell's C were lower than the values of the other groups (AUC and Harrell's C of .63; Table 9).

Table 9

*10-year Sexual Recidivism Rates, Static-99R Scores, and AUC values for White, Black, and Hispanic Sex Offenders*

| Racial groups | Recidivism rate (%) | Number of recidivists/total | *M (SD)* | AUC | Harrell's C |
|---|---|---|---|---|---|
| White | 10.6 | 14/132 | 2.42 (2.38) | **.849 [.736, .961]** | **.833 [.682, .984]** |
| Black | 10.8 | 10/93 | 2.85 (2.15) | .628 [.421, .836] | .634 [.456, .811] |
| Hispanic | 11.8 | 10/85 | 2.11 (2.24) | .696 [.478, .914] | **.689 [.510, .869]** |
| Total | 10.4 | 35/338 | 2.43 (2.25) | **.751 [.651, .850]** | **.744 [.649, .838]** |

The 10-year sexual recidivism rate at score of 2 was 6.1% and odds ratio was 1.57 ($B0_2$ = -2.740, *SE* = .255; *B1* = .448, *SE* = .084; Table 10 and Figure 5). Among the ethnic groups, the overall rate was lower for White sex offenders (3.6%) compared to Black and Hispanic groups (8.0% and 9.4%, respectively), but the differences between ethnic groups were not statistically significant ($Q_{between}$ = 2.46, *df* = 2, *p* = .292; Table 10 and Figure 6).

The discrimination (change in relative risk) was highest for White sex offenders and lowest for Black sex offenders (odds ratios = 1.29 to 1.99), but the differences between ethnic groups were not statistically significant ($Q_{between}$ = 4.13, *df* = 2, *p* = .127; Table 10 and Figure 6).

Table 10

*Logistic Regression Parameters for Static-99R Predicting 10-Year Sexual Recidivism for White, Black, and Hispanic Sex Offenders*

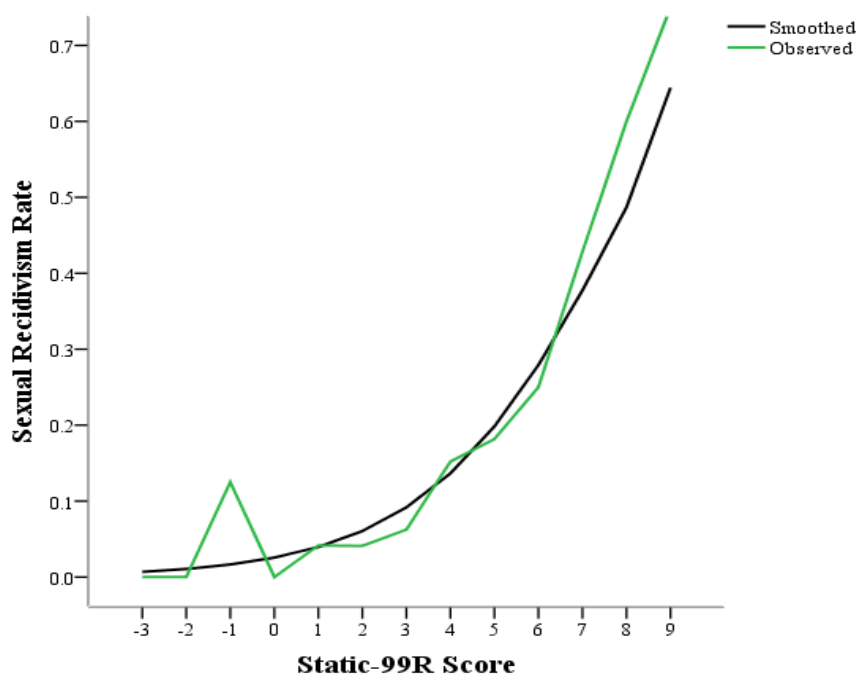| Racial group | Base rate (Static-99R score of 2 in logit units) | | Relative risk | | | 95% C.I. | |
|---|---|---|---|---|---|---|---|
| | $B0_2$ | SE | B1 | SE | OR | Lower | Upper |
| White | -3.287 (3.6%) | .533 | .690 | .170 | **1.99** | 1.43 | 2.78 |
| Black | -2.447 (8.0%) | .426 | .251 | .144 | 1.29 | 0.97 | 1.70 |
| Hispanic | -2.265 (9.4%) | .406 | .338 | .157 | **1.40** | 1.03 | 1.91 |
| $Q$ ($df = 2$) | 2.46, $p = .292$ | | 4.13, $p = .127$ | | | | |
| $I^2$ | 18.68 | | 51.63 | | | | |
| Average (fixed-effect) | -2.570 (7.1%) | .257 | .403 | .080 | **1.50** | 1.25 | 1.78 |
| Overall | -2.740 (6.1%) | .255 | .448 | .084 | **1.57** | 1.33 | 1.85 |



*Figure 5*. Observed recidivism rates per Static-99R risk score and the smoothed logistic curve.
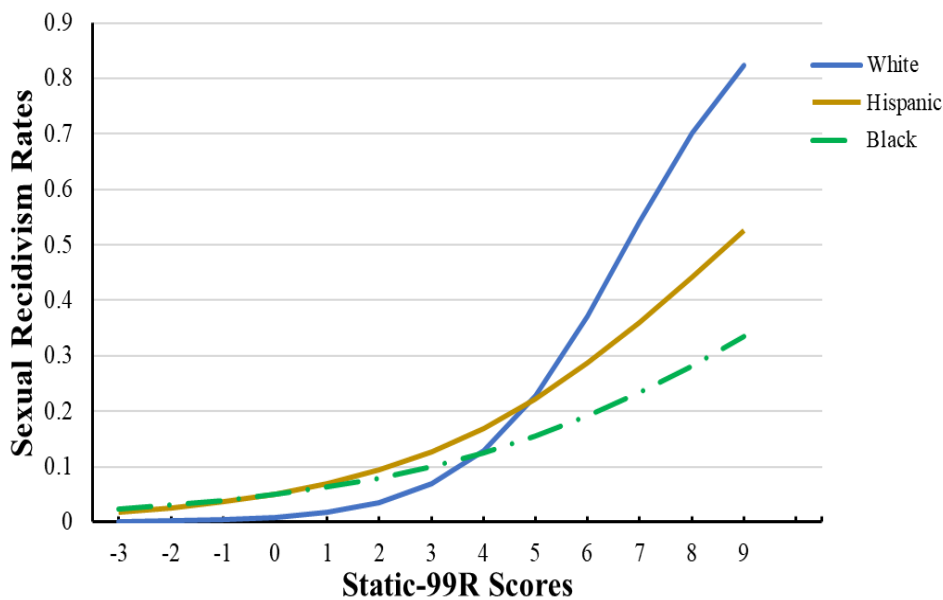
*Figure 6*. Logistic curves for White, Black, and Hispanic sex offenders.

For the 10-year sexual recidivism, there was a significant interaction between Static-99R and ethnicity (see Table 11). Specifically, when compared to White, Blacks had higher sexual recidivism rates for low/average Static-99R scores and lower sexual recidivism rates for high Static-99R scores (Level IVb). A similar pattern was observed when Latinos were compared to Whites, although the differences in this comparison were no more than would be expected by chance.

Table 11

*Interaction Effect between Static-99R and Ethnic Groups*

| Variables | B | SE | Wald $\chi^2$ | p |
|---|---|---|---|---|
| Static-99R | 0.69 | 0.17 | 16.5 | < .001 |
| White vs. Hispanic | 1.73 | 1.04 | 2.77 | .096 |
| White vs. Black | 1.72 | 1.05 | 2.70 | .101 |
| Interaction | | | | |
| Static-99R * (White vs. Hispanic) | -.352 | .231 | 2.32 | .128 |
| Static-99R * (White vs. Black) | -.439 | .223 | 3.88 | **.049** |

*Note.* Dependent variable = sexual recidivism within a fixed 10-year follow-up period.

**Calibration**

The overall resulting logistic equation indicated a relative risk increase of 1.57 for each increase in Static-99R score ($e^{.448} = 1.57$), and an adjusted 10-year sexual recidivism rate of 6.1% for a Static-99R score of 2 ($[1/\{1+e^{-(-2.740)}\}] = .0607$.

Calibration could not be tested because the Static-99R user guidance does not currently have norms for routine/complete samples at 10-year follow-up. In order to provide some information concerning whether the California 10 year rates were higher or lower than expected, the adjusted (score of 2) 10-year base rate ($B0_2$) and relative risk rate ($B1$) were compared to the outcomes from other 10-year follow-up studies of routine/complete samples (4 studies).[30,31,32,33]

The result by a fixed-effect meta-analysis found that the adjusted (score of 2) base rates were not significantly different among the studies ($Q_{between} = 1.77$, $df = 4$, $p = .777$), and neither were the relative risk rates ($Q_{between} = 2.05$, $df = 4$, $p = .727$; Appendix A). Consequently, the California 10-year sexual recidivism rates were in line with those observed in other jurisdictions (Canada, Sweden, North Dakota, New Jersey).

**Time-Dependent Discrimination**

Figure 7 displays the Schoenfeld residuals for the Static-99R score plotted against time. The relationship between Static-99R scores and sexual recidivism appears to be slightly decreased as time passed, but the relationship (i.e., the slope) was not significantly different from zero, $\rho = -0.22$, $\chi 2 = 2.04$, $p = 0.15$.
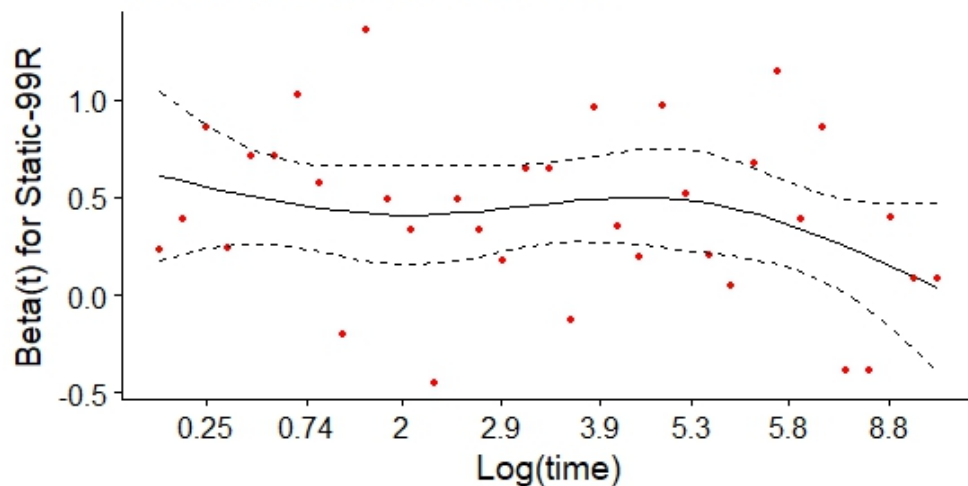
*Figure 7*. Scatterplot of scaled Schoenfeld residuals resulting from Cox regression model with Static-99R for 10-year follow-up period, with a solid line of best fit (a smooth spline) and the dashed lines representing a +/- 2 standard-error band around the fit, superimpose onto the graph.

The time-dependent AUC values are displayed in Figure 8. As seen in the figure, the predictive accuracy of Static-99R was consistently good across the 10-year follow-up time (all AUCs were above 0.70).
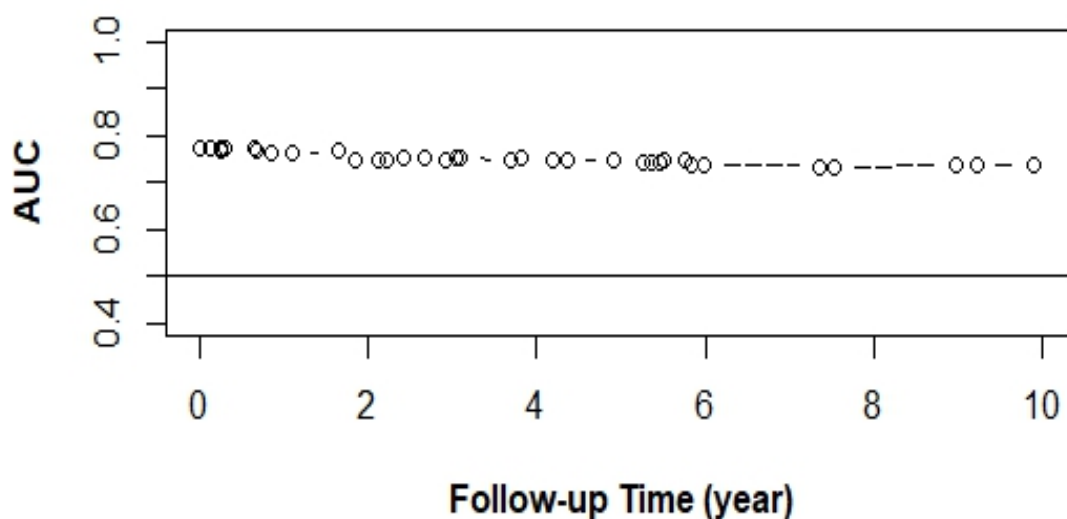


*Figure 8*. Time-dependent Area under the Curve (AUC) statistics graphed across the 10-year follow-up period.

**Discussion**

This prospective study found overall good predictive accuracy (specifically, discrimination) of Static-99R across a 10-year follow-up period. Although the AUC decreased to .75 within a 10- year follow-up from .81 within a 5-year follow-up, the effect was still large, and the change was not statistically significant. The odds ratios from logistic regression also similar for 5-year ($OR = 1.66$) and a 10-year ($OR = 1.57$) follow-up periods. These odds ratios were comparable, if slightly larger, to the Static-99R norms and the values from other 10-year follow-up studies.

The discrimination of Static-99R within 5 years across ethnic groups (White, Black, and Hispanic) was good (all AUCs > .72 and odds ratios > 1.44) and compared favorably to the average values of discrimination for Static-99R in diverse settings (AUC = .70 and odds ratio = 1.45; Hanson et al., 2016).[7] Within a fixed 10-year follow-up, the good discrimination of Static-99R for White and Hispanic groups was consistent with time; however, the discrimination for Black sex offenders decreased to the AUC of .63 and odds ratio of 1.29, although the effects were still moderate.

When compared to the norms for a 5-year routine sample, the overall calibration was good. The observed 5-year sexual recidivism rate (6.2% after 5 years) was lower than the norms (8.3%), but the difference was not statistically significant ($E/O = 1.34$). In particular, the observed sexual recidivism rate was only significantly lower than the norms ($E/O = 2.68$) for the Level III risk group (scores of 1 to 3). The adjusted (score of 2) base rate was also significantly lower than the norms (2.8% vs. 5.6%).

In sub-analyses across ethnic groups (White, Black, and Hispanic) within 5 years, the study found good overall calibrations for each ethnic group across all the risk levels (Level I, II,

III, IVa, and IVb). Previous California studies found unexpectedly low sexual recidivism rates for Hispanic sex offenders (i.e., poor calibration) compared to other ethnic groups (White or Black).[8,9,10,34] The current study found that the apparently low rates could largely be explained by the high rates of deportation among the Hispanic subsample. Almost one-third of Mexicans (the largest group in the Hispanic group) in the United States are foreign born compared with 13% of the U.S. population.[35] We found very high deportation rate (about 40%) for Hispanic sex offenders after sexual offense or release when compared to about 2% deportation rate for White or Black sex offenders. Approximately 90% of the overall deportees in this study were Hispanics. Consequently, after excluding the deportees from the calibration analysis, the sexual recidivism rates for Hispanic sex offenders became comparable with the sexual recidivism rates for White and Black ethnic groups, as well as the norms of Static-99R.

We also found support for the offense-free effect (length of time that an offender remains offense-free in the community after release) on this specific California sample. The risk of sexual recidivism predictably declines the longer individuals remain sex offense-free in the community. It is recommended, thus, to consider the time they have been sex offense-free in the community in the overall evaluation of risk (see Figure 3 in Hanson et al., 2017).[12]

**Limitations**

The current study still had limited statistical power to make confident conclusions due to the small sample sizes, especially for the sub-analyses with each ethnic group (10 or fewer recidivists). Additional research with a large number of each ethnic group is recommended for a long follow-up period. Consequently, it is difficult to know how much of the decreased predictive accuracy for Blacks after 10-years compared to 5-years is meaningful, or simply chance variation due to small samples.

We were not able to conduct calibration analyses for 10-year sexual recidivism rates because there were no Static-99R norms for routine/complete samples for 10-year follow-up periods. Comparisons to other studies, however, provided some evidence that the 10-year sexual recidivism rates in this California sample were comparable to the rates observed in other jurisdictions.

**Conclusions**

The current study found that Static-99R worked well to predict the likelihood of sexual recidivism in California across 10 years. Although the overall magnitudes of AUC values with a 10-year follow-up period are slightly lower than in a 5-year follow-up period, they were all still above average compared to other studies. The expected sexual recidivism rates from the norms of Static-99R well corresponded with the observed sexual recidivism rates in this California samples. Consequently, the current findings support the continued use of Static-99R in California for 10-year risk prediction. It is recommended to consider the time they have been sex offense-free in the community in the overall evaluation of risk.

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Appendix A

10-year Follow-Up Studies for Static-99R

| Studies | Recidivism rate (%) | Number of recidivists/total | Base rate (Static-99R score of 2 in logit units) | | Relative risk | |
|---|---|---|---|---|---|---|
| | | | $B0_2$ | SE | B1 | SE |
| Boer (2003) | 7.80 | 23/295 | -3.23 | .359 | .378 | .095 |
| Epperson (2003) | 22.2 | 8/36 | -3.65 | 1.53 | .794 | .290 |
| Långström (2004) | 7.37 | 26/353 | -2.98 | .280 | .406 | .086 |
| Mercado, Jeglic, & Markus (2011) | 9.01 | 10/111 | -2.73 | .490 | .260 | .178 |
| California (Current Study) | 9.17 | 31/338 | -2.74 | .255 | .448 | .084 |
| $Q$ (df = 4) | | | 1.77, $p$ =.777 | | 2.05, $p$ = .727 | |
| $I^2$ | | | .00 | | .00 | |
| Average (fixed-effect) | | | -2.92 | .157 | .412 | .048 |

Appendix B

Sexual Recidivism Rates for Each Static-99R Score

**Overall**

| Static99R Score | Fixed 5-year follow-up period | | Fixed 10-year follow-up period | |
|---|---|---|---|---|
| | % | n/N | % | n/N |
| -3 | 0.00 | 0/4 | 0.00 | 0/2 |
| -2 | 0.00 | 0/3 | 0.00 | 0/1 |
| -1 | 3.57 | 1/28 | 12.5 | 3/24 |
| 0 | 0.00 | 0/43 | 0.00 | 0/42 |
| 1 | 3.70 | 2/54 | 4.17 | 2/48 |
| 2 | 0.00 | 0/79 | 4.11 | 3/73 |
| 3 | 3.77 | 2/53 | 6.25 | 3/48 |
| 4 | 10.2 | 5/49 | 15.2 | 7/46 |
| 5 | 12.0 | 3/25 | 18.2 | 4/22 |
| 6 | 17.6 | 3/17 | 25.0 | 4/16 |
| 7 | 28.6 | 2/7 | 42.9 | 3/7 |
| 8 | 60.0 | 3/5 | 60.0 | 3/5 |
| 9 | 33.3 | 1/3 | 66.7 | 2/3 |
| 10 | - | - | - | - |
| 11 | 100.0 | 1/1 | 100.0 | 1/1 |
| 12 | - | - | - | - |
| Total | 6.20 | 23/371 | 10.4 | 35/338 |

**White**

| Static99R Score | Fixed 5-year follow-up period | | Fixed 10-year follow-up period | |
|---|---|---|---|---|
| | % | n/N | % | n/N |
| -3 | 0.00 | 0/3 | 0.00 | 0/1 |
| -2 | 0.00 | 0/1 | 0.00 | 0/1 |
| -1 | 0.00 | 0/14 | 0.00 | 0/11 |
| 0 | 0.00 | 0/19 | 0.00 | 0/18 |
| 1 | 5.56 | 1/18 | 6.25 | 1/16 |
| 2 | 0.00 | 0/27 | 4.00 | 1/25 |
| 3 | 5.00 | 1/20 | 5.26 | 1/19 |
| 4 | 4.76 | 1/21 | 10.0 | 2/20 |
| 5 | 22.2 | 2/9 | 25.0 | 2/8 |
| 6 | 22.2 | 2/9 | 37.5 | 3/8 |
| 7 | - | - | - | - |
| 8 | 66.7 | 2/3 | 66.7 | 2/3 |
| 9 | 0.00 | 0/1 | 100.0 | 1/1 |
| 10 | - | - | - | - |
| 11 | 100.0 | 1/1 | 100.0 | 1/1 |
| 12 | - | - | - | - |
| Total | 6.85 | 10/146 | 10.6 | 14/132 |

**Black**

| Static99R Score | Fixed 5-year follow-up period | | Fixed 10-year follow-up period | |
|---|---|---|---|---|
| | % | *n/N* | % | *n/N* |
| -3 | - | - | - | - |
| -2 | - | - | - | - |
| -1 | 0.00 | 0/4 | 25.0 | 1/4 |
| 0 | 0.00 | 0/5 | 0.00 | 0/5 |
| 1 | 5.88 | 1/17 | 7.14 | 1/14 |
| 2 | 0.00 | 0/28 | 3.85 | 1/26 |
| 3 | 7.69 | 1/13 | 16.7 | 2/12 |
| 4 | 11.1 | 2/18 | 12.5 | 2/16 |
| 5 | 0.00 | 0/7 | 0.00 | 0/6 |
| 6 | 0.00 | 0/3 | 0.00 | 0/3 |
| 7 | 33.3 | 1/3 | 33.3 | 1/3 |
| 8 | 50.0 | 1/2 | 50.0 | 1/2 |
| 9 | 50.0 | 1/2 | 50.0 | 1/2 |
| 10 | - | - | - | - |
| 11 | - | - | - | - |
| 12 | - | - | - | - |
| Total | 6.86 | 7/102 | 10.8 | 10/93 |

**Hispanic**

| Static99R Score | Fixed 5-year follow-up period | | Fixed 10-year follow-up period | |
|---|---|---|---|---|
| | % | *n/N* | % | *n/N* |
| -3 | 0.00 | 0/1 | 0.00 | 0/1 |
| -2 | 0.00 | 0/2 | - | - |
| -1 | 11.1 | 1/9 | 25.0 | 2/8 |
| 0 | 0.00 | 0/15 | 0.00 | 0/15 |
| 1 | 0.00 | 0/14 | 0.00 | 0/13 |
| 2 | 0.00 | 0/15 | 7.69 | 1/13 |
| 3 | 0.00 | 0/16 | 0.00 | 0/13 |
| 4 | 22.2 | 2/9 | 33.3 | 3/9 |
| 5 | 14.3 | 1/7 | 33.3 | 2/6 |
| 6 | 0.00 | 0/3 | 0.00 | 0/3 |
| 7 | 25.0 | 1/4 | 50.0 | 2/4 |
| 8 | - | - | - | - |
| 9 | - | - | - | - |
| 10 | - | - | - | - |
| 11 | - | - | - | - |
| 12 | - | - | - | - |
| Total | 5.26 | 5/95 | 11.8 | 10/85 |